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ABSTRACT:

A rotary motor (110) having a cylinder block rotatably

mounted within a cylinder housing (111). The cylinder block comprises cylinders (116) with piston members (115) rotatably supported on a shaft (113) journalled for rotation in the housing (111). The piston members (115) and the housing (111) define working chambers which vary in volume in response to their relative movements to induct a pre-compressed charge from an underside of the piston members (115), through a transfer port arrangement. Offset pairs of opposed cylinders (116) have correspondingly offset exhaust valves, one being provided for each pair.

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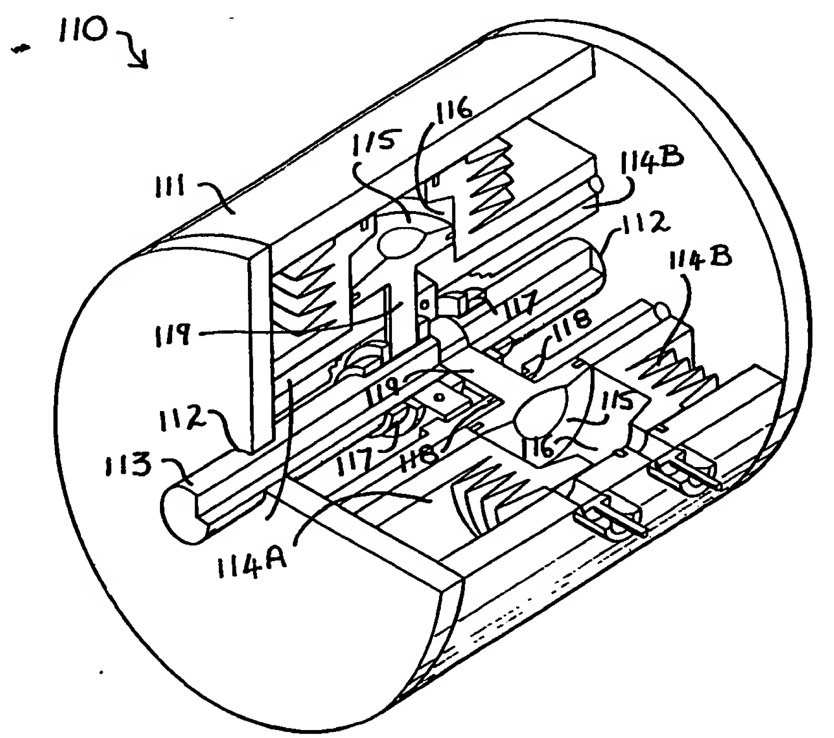

(57) Abstract

A rotary motor (110) having a cylinder block rotatably mounted within a cylinder housing (111). The cylinder block comprises cylinders (116) with piston members (115) rotatably supported on a shaft (113) journalled for rotation in the housing (111). The piston members (115) and the housing (111) define working chambers which vary in volume in response to their relative

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BI-ROTARY ENGINE

FIELD OF THE INVENTION

This invention relates to motors of the rotary type including a housing, a cylinder block supported to move within the housing containing a plurality of cylinders varying in volume, in sequence, in response to the relative movement between the piston members and the housing. The motor may be in the form of a heat engine operating on internal or external combustion or a hydraulic or pneumatic motor.

BACKGROUND ART

There have been proposed numerous constructions of motors wherein the relative movement between the piston member and the housing is rotational and employing the two stroke cycle of operation. However, both the strength of the piston and connecting rod assembly, and the port timing have been compromised. In addition, in the late twentieth century, it is necessary to address and keep to a minimum the pollution created by the engine.

Three particularly relevant patents which illustrate the nature of the motor or engine under consideration are U.S. Patent No. 2,683,422 (A. Z. Richards Jnr.), U.S. Patent No. 3,200,797 (Dillenberg) and U.S. Patent No. 3,517,651 (Graybill). The entire disclosure and drawings of those three U.S. patents is incorporated herein by cross reference.

DISCLOSURE OF THE INVENTION

It is therefore an object of this invention to provide a two stroke motor, of the rotary piston type, which

addresses one or more of the abovementioned problems.

According to the present invention there is provided, a motor of the rotary type including a cylinder block rotatably mounted within a cylinder housing, a shaft journalled for rotation in said housing, piston members rotatably supported on the shaft for rotary motion in the cylinder housing as the shaft and the cylinder block rotate and a plurality of cylinders arranged to define chambers between the housing and the piston members that vary in volume, in sequence, in response to the relative movement between the piston members and the housing.

Conveniently, the housing is formed by a peripheral wall and opposed end walls, with each cylinder supported on the central carrier for rotational movement. The central carrier being supported on two bearings, one on each of the respective end walls.

The piston may have a rod portion extending from the piston base, through a gas/oil seal, to the crankshaft bearing. The crankshaft is connected to the central carrier by epicyclic gears giving a 2:1 reduction. One complete revolution of the crankshaft causes 180° rotation of the cylinder block.

By providing running clearance between the piston rod, at the bearing end, and the central carrier, side thrust may be reduced between the piston and cylinder during rotation under operating conditions, resulting in a reduced rate of wear and reduced friction.

Also, if the piston in the cylinder is connected to the crankshaft by a centrally located rod, it allows for a lighter piston construction.

The bearing pads may be formed as an integral part of the piston rod, with or without a surface coating of bearing material, or may be an insert attached thereto. The insert may be made entirely of suitable bearing material, such as phosphor bronze, or may be made of any other material of suitable mechanical and thermal properties with a layer of suitable bearing material on the bearing face. Preferably, the insert is attached to the rod, since the latter experiences less thermal distortion during engine operation and hence provides a more constant reference for the insert.

The present invention is particularly applicable to internal combustion engines wherein the cylinders are supported in the housing for rotation in a direction normal to the plane of the crankshaft as is, and the pistons are connected to the crankshaft so that each piston may move relative thereto in a direction normal to the direction of reciprocation of the eccentric bearing. The piston member is provided with seals around its circular edge, fitting snugly into the rotating cylinder, allowing for running clearance.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more readily understood from the following description of an internal combustion engine incorporating the present invention, as illustrated in the accompanying drawings. It is understood that although the invention is described with respect to an internal combustion

engine, it may also be applied to other forms of motors, such as hydraulic motors or steam engines of the rotary type.

Embodiments of the invention will now be described with reference to the drawings wherein:-

Fig. 1	is a perspective, part section view of a two stroke, rotary engine according to a first embodiment of the invention,
Fig. 2	is a vertical section view through the engine of Fig. 1,
Fig. 3	is a horizontal section view through the engine of Fig. 1,
Fig. 4	is an end section view along lines C-C through the engine of Fig. 1,
Fig. 5	is an end section view along line D-D of the engine of Fig. 1,
Fig. 6	is a vertical section through the engine of a second embodiment of the invention,
Fig. 7	is a horizontal section through the engine of the second embodiment,
Fig. 8	is a cross-sectional view through the engine of the second embodiment,
Fig. 9	is a further cross-section view through the engine of a second embodiment,
Fig. 10	is a vertical section through the cylinders of the engine of the second embodiment,
Fig. 11	is a horizontal section through the cylinders of the engine of the second embodiment,

Fig. 12	is a plan view of the inlet cylinders sealing ring of the engine of the second embodiment with selected cross sectional views therethrough,
Fig. 13	is a plan view of the inlet casing-side sealing ring and exhaust sealing plate and support pads together with selected cross-sectional views therethrough,
Fig. 14	is a side section view through the exhaust manifold in vertical and horizontal section,
Fig. 15	is a side section view through an engine cylinder and port of the second embodiment illustrating a first position of operation,
Fig. 16	is a side sectional view as for Fig. 15 and showing a second position of operation,
Fig. 17	is a side section view as in Fig. 15 and showing a third position of operation,
Fig. 18	is a side section view as for Fig. 15 and illustrating a fourth position of operation,
Fig. 19	is a side section view as in Fig. 15 and showing a fifth position of operation of the engine of the second embodiment,
Fig. 20	is a side section view comparing the piston rings of the engine of the second embodiment to conventional piston rings,

Fig. 21	is a plan view of sealing arrangements of the engine of the second embodiment including the cylinder seal ring and the end plate seal ring,
Fig. 22	is a side section view through the casing of the engine of the second embodiment illustrating the relationshipe between the air and transfer tracks according to the second embodiment,
Fig. 23	is a plan view of an exhaust sealing ring according to the second embodiment of the invention,
Fig. 24	is a side section view of a piston and cylinder housing according to a second embodiment of the invention,
Fig. 25	is an in section view of an engine according to a third embodiment of the invention,
Fig. 26	is an alternative view of the end section of Fig. 24,
Fig. 27	is a vertical section view through the engine according to a third embodiment,
Fig. 28	is a horizontal section through the engine according to a third embodiment,
Fig. 29	is a plan view of a cylinder side sealing ring according to a third embodiment of the invention,

Fig. 30 is a plan view of a case side sealing ring according to a third embodiment of the invention,

Fig. 31 is a perspective view of a half portion of the crank case of the engine according to a third embodiment,

Fig. 32 is a vertical section view of an engine according to a fourth embodiment of the invention,

Fig. 33 is a horizontal section of the engine according to a fourth embodiment of the invention,

Fig. 34 shows details of an exhaust sealing plate and exhaust tube which may be used with any one of the first to fourth embodiments of the invention.

MODES FOR CARRYING OUT THE INVENTION

With reference to Figs. 1 to 5 inclusive an engine 110 according to the first embodiment comprises an engine casing 111 within which rotates a crank shaft 113 and a central carrier or cylinder block 114.

Pistons 115 reciprocate within cylinders 116 within the central carrier/cylinder block 114 thereby causing relative rotation of both the cylinder block 114 and of crank shaft 113 with respect to engine casing 111.

The crank shaft 113 is geared to casing 111 by epicyclic gears 117 of ratio 2:1.

From the drawings of the vertical and horizontal sections, it can be seen that the crankshaft is mounted securely in the engine casing 111 by the main bearings, allowing the crankshaft to rotate but to remain, at all times, in the same relative position with respect to the common centre of the cylinder axes. The epicyclic gears 117 give a ratio of 2:1 between the central carrier 114 of the cylinders and the crank shaft. The central carrier 114 is mounted on bearings to maintain the running clearance between the cylinders and the casing. The central carrier 114 is in two parts 114A, 114B, bolted together to clamp the split seals 118 around the connecting rods 119 and allowing the piston 115 and connecting rod 119 to be one piece for greater strength.

With particular reference to Fig. 3, induction is accomplished by the under side 122 of the piston 115 drawing gas through the inlet port 120 when it is in line with the inlet tract 121. As the cylinder block 114 rotates and the piston reaches T.D.C., the port is closed by the seal between the inlet and transfer tracts pressing against the cylinder block by spring pressure.

The gas under the piston is now forced back through the cylinder port into the transfer tract 123. From the transfer tract it goes to the rotary valve 124, turning at crank shaft speed, and synchronised to open when the cylinder passes. As the cylinder passes and the valve opens 124, the gas is

forced into the cylinder 116. The valve closes preventing any gas escaping to atmosphere after the cylinder has passed.

Above the piston 115, the gas is compressed and as the piston reaches T.D.C., or thereabouts, the spark plug 125, at the appropriate position in the engine casing 111, is timed to ignite the mixture. The power stroke continues until the exhaust port 126 is uncovered by the rotating cylinder at a point just before B.D.C. This permits a much longer use of the available energy than is common in traditional engines.

The uncovering of the exhaust port 126 allows the gas to escape instantaneously under its own pressure, lifting the exhaust valve 127 automatically off its seals. The other exhaust valve remains closed to prevent the gas exhausting directly to atmosphere. There are two exhaust valves because the pairs of cylinders are staggered. The rotary valve opens 124 after the exhaust port has closed, allowing the charge to enter the cylinder and avoiding any possibility of fresh charge escaping down the exhaust pipe 128. The rotary valve 124 closes when the cylinder has passed by and the gas is then compressed by the piston in preparation for the next power stroke.

The engine is described with carburettor and spark-plug ignition but fuel injection and /or diesel principles may be used. The engine may be air and/or liquid cooled.

Features of forms of the described arrangements include:-

1. The port timing is controlled by the side of the cylinder casing, not the peripheral passing of

the cylinder nor the movement of the piston itself.

2. In a naturally aspirated engine there is no pollution of the exhaust gas by fresh incoming charge because the exhaust port is closed before the transfer port opens.

3. The big-end of the con-rod runs in guides in the central housing reducing the side loads on the pistons.

4. Also, related to point 3, the crankshaft is geared to the casing for the same reason but, unlike Dillenberg, the gears are not direct. The introduction of the two idler gears allows the gears themselves to be larger while still maintaining the correct direction of rotation, thus allowing the crankshaft to be made as thick (strong) as required. Otherwise the strength of the shaft is compromised for the sake of the gearing.

5. Because of the side port arrangement, the gas seal is necessary in at least some of the preferred embodiments.

6. The inclusion of a rotary valve in the transfer tract removes the reliance on sealing from the peripheral seal in the rotating cylinder section to the valve itself. Therefore it is possible to run the engine without the peripheral seal, allowing cooling air, from time to time, to pass

directly over the spark plugs and the exhaust valves to keep them within safe operating conditions.

7. The exhaust valves are paired because the cylinders are offset, with one valve for each pair of opposed cylinders. The valves can be pressure released (as shown) or timed mechanically as in conventional engines. The reason for a valve at all is because the exhaust gas could escape from one cylinder and then exhaust directly to atmosphere through the other open port, instead of travelling down the exhaust pipe to the silencer.

A second embodiment of the invention will now be described with reference to Figs. 6 to 21.

Figs. 6 to 11 illustrate various sectional views of an engine according to a second embodiment of the invention.

The induction and compression phases for this engine are much the same as for the engine of the first embodiment. Similarly, the crank shaft arrangement is the same.

Oil pump and oilways have not been shown in these figures.

The major difference as compared with the first embodiment is that the sealing rings are constructed differently (refer detailed description in respect of Figs. 20 and 21 later in this specification).

The ignition strip is chamfered on its leading edge so that when the cylinders expand, the top of the spark plug pushes the high tension copper strip, against spring pressure, into the cavity in the housing without jamming. One high tension lead for each strip is required because of the staggered cylinders, which is why they are independently sprung. The length of the strip allows the required ignition advance without the need for separate pick ups, etc. In Figs. 6 to 11 the sealing rings have been drawn superimposed upon each other.

With particular reference to Figs. 6, 7, 8 and 9 the interconnection of components of the engine according to the second embodiment of the invention is as follows.

The engine comprises a crank shaft 1 having a crank pin 2 and journalled for rotation in main bearing 3. A planetary gear arrangement comprising crank shaft gear 4, idler gear 5 and crank case gear 6 place the crank case 7 in rotary engagement with crank shaft 1.

Piston and connecting rod 8 act to cause rotary motion of crank shaft 1 via crank pin 2.

Piston and connecting rod 8 are mounted for sliding, reciprocating motion within cylinder 9.

Fuel and exhaust gases communicate with the interior of cylinder 9 via inlet port 10, transfer port 11, exhaust port 12. Piston ring(s) 13 act to seal piston and connecting rod 8 against the inside surfaces of cylinder 9. Additional sealing mechanisms, as illustrated, include connecting rod

seal 14, crank case seal 15, inlet port seal 16, transfer port seal 17, inlet tract seal 18, transfer tract seal 19, inlet casing-side sealing ring spacing rubber 20, inlet casing-side sealing ring 21, inlet cylinder-side sealing ring 22, exhaust sealing plate 23, exhaust sealing ring stabilising pad 24, exhaust sealing ring 25.

The porting arrangement to pass combustion gases into and out of cylinder 9 includes inlet cylinder-side sealing ring inlet orifice 26, inlet cylinder-side sealing ring transfer orifice 27, inlet casing-side sealing ring inlet orifice 28, inlet casing-side sealing ring inner transfer orifice 29, inlet casing-side sealing ring outer transfer orifice 30 inlet casing-side sealing ring air orifice 31, exhaust sealing ring orifice 32 and exhaust sealing plate orifice 33.

Exhaust gases pass through exhaust manifold 35 sealed by exhaust manifold sealing ring 34 and pass out via exhaust pipe 39.

It will be observed particularly with reference to Figs. 6 and 7 that the engine is modular in nature being defined by parallel end casings 48 spaced at both ends from each other by end casing spacer 47. These components are held together by engine bolt 49 as illustrated. Crank shaft 1 protrudes rotatably through both opposed faces of the end casings 48 whereby the engine can be used as a single module as illustrated in Fig. 6 or can form a single module of an interconnected series of modules connected together via crank shaft 1.

Fuel and air communicate within the engine via inlet tract 36, transfer tract 37 and air tract 38. Fuel is mixed with air via carburettor 50.

Compressed fuel and air mixture is ignited within cylinder 9 by means of spark plug 40 which is in rotary, conductive communication with high tension lead 41 via high tension copper strip 42. A pressure spring 44 maintains electrical contact between the top of spark plug 40 and the high tension copper strip 42. The copper strip 42 is insulated from the high tension housing 46 by means of insulating pad 43 and the assembly is retained by retaining plate 45 as best seen in Fig. 8.

The relative position of the casing components is maintained by inlet cylinder-side sealing ring dowel locating hole 51 and inlet casing-side sealing ring dowel locating hole 52 which receive locating dowels therewithin.

As best seen in Figs. 8 and 9 a single engine module comprises, ideally, two pairs of cylinders 9 located on diametrically opposed sides of crank shaft 1 and coacting so as to urge rotation of crank shaft 1.

Respective positions of inlet and exhaust cylinder-side sealing rings are shown in Fig. 12.

Section A in Fig. 12 is the cross-section of the inlet cylinder sealing ring, taken through the inlet and transfer orifice, showing the grooves for the rubber "O" rings for gas sealing against the cylinder. The cylinder has similar grooves machined around the ports to accept these "O" rings.

Section B in Fig. 12. is the cross-section through one of the eight dowel locating holes. The dowels are pressed into the cylinder at the appropriate points and the inlet cylinder sealing ring sits on them, allowing it to float in and out, but not to rotate. When assembled, the cylinder and casing inlet sealing rings are kept pressed together because the rubber "O" rings are under compression. That is to say that the assembled clearance between the cylinder and case is less than the uncompressed thickness of the sealing rings and rubber "O" rings.

The two inlet sealing rings, both casing and cylinder, are Teflon coated on their mating surfaces.

Section C is Fig. 12 is the cross-section of the exhaust cylinder sealing ring taken through the exhaust outlet. The exhaust manifold, bolted to the cylinders, has the same function as the dowels on the inlet ring.

Fig. 13 illustrates the respective positions of inlet casing side sealing ring and the exhaust sealing plate and support pads.

Section D in Fig. 13 is the cross-section of the exhaust sealing plate taken through the exhaust outlet. The plate is ceramic coated on its rubbing surface, as are the support pads. They are sunk into the engine case to ensure that they remain in the correct position.

In Fig. 13 ceramic coated steel pad 24 is adapted to stabilise the exhaust cylinder side sealing ring.

Section E in Fig. 13 is a cross-section of the inlet casing-side ring taken through the inlet and transfer tracks, showing the grooves for the rubber sealing rings.

Section F in Fig. 13 is a cross-section of the inlet casing side sealing ring taken through the inlet track and one of the three dowel locating holes.

Section G in Fig. 13 is a hole for the air inlet so it does not need a rubber seal. It is not one of the dowel locating holes.

In Figs. 12 and 13 the exhaust manifold is on the leading edge of the cylinder for cooling air so it is not on the centre line of the cylinders. In Fig. 14 they have been drawn sectioned in the vertical and horizontal sections.

On the vertical and horizontal sections the exhaust manifold has been drawn one square further out than it actually is for explanatory purposes - so that the exhaust sealing ring is clear of the inlet sealing rings. Fig. 14 illustrates their relationship as it really is.

The exhaust manifold is "T" shaped so that there is an exhaust pipe on each side (as also there are two carburettors). By making the exhaust manifold "L" shaped, it is possible to have the carburettors and the exhaust on the same side for fitting into a car for example with the clutch on the other side. Or, as above with one carburettor and one exhaust on opposite sides.

The operation of the engine of the second embodiment, particularly around bottom dead centre (B.D.C.), will now be described with reference to Figs. 15 to 19 inclusive which

illustrate progressive operational phases of the engine.

Fig. 15 shows the piston on the power stroke. The exhaust pipe 39 is already open to the exhaust manifold 35 by the exhaust sealing plate orifice 33 lining up with the exhaust sealing ring orifice 32. This is done before the piston 8 uncovers the exhaust part 12 so that the minimum restriction is offered to the exhausting gas. The exhaust sealing ring 25 has a smaller diameter outlet 32 than the diameter of the exhaust manifold 35 to ensure that the higher gas pressure on the cylinder side forces the exhaust sealing ring 25 firmly against the ceramic coated exhaust sealing plate 23 to seal it effectively. The exhaust manifold sealing rings 34 act in the same way as piston rings to ensure an effective seal between the exhaust sealing ring 25 and the exhaust manifold.

The under side of the piston is compressing the fresh charge into the transfer track 37.

Fig. 16 shows the piston 8 approaching B.D.C. after the high pressure gas in the cylinder 9 has been released down the exhaust pipe 39. Although the transfer port 11 had been uncovered by the piston 8 after the exhaust port 12 had opened, the transfer of fresh gas was stopped by the inlet casing-side sealing ring 21. Now the transfer port 11 is opened directly to atmosphere by the inlet casing-side sealing ring air orifice 31 lining up with inlet cylinder-side sealing ring transfer orifice 27, allowing fresh cold air to pass across the top of the piston 8 having been induced into the cylinder 9 by the low pressure created by

the exhausting gas. This purges the cylinder 9)of any residual exhaust gas while returning the pressure inside the cylinder 9 to atmospheric.

Fig. 17 shows the piston 8 at B.D.C. where the exhaust sealing ring orifice 32 the inlet cylinder-side sealing ring transfer orifice 27 and the inlet cylinder-side sealing ring inlet orifice 26 are all closed.

Fig. 18 shows the piston 8 commencing the compression stroke. The transfer port 11 is open to the transfer tract 37 by the inlet cylinder-side sealing ring transfer orifice 27 lining up with the inlet casing-side sealing ring outer transfer orifice 30. The transferred gas cannot escape to pollute the exhaust because the exhaust sealing ring orifice 32 is closed by the ceramic coated exhaust sealing plate 23.

The underside of the piston 8 commences the induction stroke.

Fig. 19 shows the piston 8 has closed the exhaust port 12 at which point the exhaust sealing ring 25 may be opened to atmosphere for cooling purposes.

Note that the air passages in the casing are referred to as "tracts", in the cylinder as "ports" and in the seal rings as "orifices".

A detailed description of the piston ring arrangement according to the second embodiment of the invention will now be described with reference to Figs. 20 and 21.

Fig. 20 shows the cylinder head being separate from the cylinder with conventional piston rings 13 being situated on the upper outer part of the cylinder, being covered by the

skirt of the cylinder head. That is the cylinder head fits over and around the top of (or the outer end of) the cylinder. After ignition, the pressure in the cylinder forces the pistons inwards and the cylinder head outwards against the casing. The cylinder head should be coated on its outer edge with heat resistant low friction material, such as silicon nitride. Lubrication of the rubbing surface can be achieved by a low pressure, total loss oil supply to the inside of the engine casing, through very small holes drilled at any number of required points.

Any gas which might otherwise escape between the cylinder head and the top of the cylinder will be stopped by the piston rings, as with a normal piston.

Fig. 21 shows the side-port seals. It is a variation on the first embodiment in that the original sealing rings were required to rub against the moving cylinder. The system of Fig. 21 uses a separate plate 53, teflon coated, with holes 54 machined in it to line up with the original ports 56 in the cylinder and/or end plates.

In the enlargement in Fig. 21 of the rubber ring and groove, it can be seen that the ring is only partly entered into each groove for location whilst allowing pressure on the assembly to ensure continued sealing.

The plate is located in its position by at least the steel dowel pins 55, sunk into the cylinder and into the sealing plate 53. The pin locating hole is blind so that the steel dowel pin does not touch the rubbing/sealing surface of the plate.

Between the sealing plate and the cylinder, around each port, is a synthetic rubber sealing ring, settled part into a groove in the cylinder and part into a groove on the back side of the sealing plate. The ring is held in position by (a) gasket sealant and (b) pressure upon assembly ensuring that the sealing ring is pressed firmly against its mating surface but not too much to actually close the gas around the rubber ring.

This allows the sealing function to be accomplished by the teflon coated surface of the plate 53 rubbing against its mating surface. The plate is always in line with its relative ports because of the dowel pins 55. Variations due to expansion upon warming up during the course of operation are handled by the synthetic rubber rings behind the plate, being under compression and coated with sealant.

This sealing system can be used on the end plate tracts as well whereby it is possible to have both plates floating and rubbing against each other. Each seal ring is a full circle ensuring contact at all times. A system for desmodronic valve operation can be used for actuating the exhaust valves. A positive stop mechanism can be used for the gearbox if space is limited.

With references to Figs. 22, 23 and 24 further differences between the engine of the second embodiment as compared with that of the first embodiment are highlighted.

The engine of the second embodiment has been simplified somewhat as compared with that of the first embodiment. The side seals, pistons and induction system are the same. The

engine of the second embodiment allows for separate cylinder heads and no outside casing. In the second embodiment gas will not be directed externally to the rotary valve but will enter the cylinder by a port opened towards the end of the piston stroke (similar to an ordinary two stroke engine). Also the gas will exhaust by a similar port on the opposite side, opened before the tranfer port (as is also normal two stroke practice).

In the second embodiment, with reference to Fig. 22, a difference in the side seals is that there is also another transfer tract 58, concentric with and outside the original transfer tract 37, to direct the gas back into the cylinder instead of around the outside to the rotary valve 124. Fig. 22 shows that the air port 57 is opened to atmosphere after the exhaust port 12 has opened but closes at the same time. Thus both ports are closed before the transfer port 11 opens.

Fig. 23 illustrates a ceramic coated exhaust sealing ring 59 bolted to the cylinder block. The ports line up with the ports described with reference to Fig. 22. The inlet/transfer sealing ring is similar to the exhaust ring except that it has two ports. It is pinned, not bolted and is urged against the other plate by spring pressure. The sealing ring is teflon coated.

Fig. 24 highlights the location of the differences in connection of the exhaust tracts, transfer tracts and inlet and air tracts to the cylinder volume in respect of the second embodiment of the invention. The inlet/transfer tract

is the same as for the first embodiment but is now located on one side only.

It will be appreciated that this arrangement of the second embodiment includes the following features:-

1. Because of the heat, only one side of the engine will be used for induction and transfer. The other side will be only for exhaust.

2. Because the transferred gas enters by another cylinder port, another transfer tract is required. This is joined to the original transfer tract by a groove machined in the engine casing.

3. Because the port in the cylinder is only uncovered by the piston for a relatively short time, this second transfer tract is very short.

4. When the piston is descending on the power stroke, the exhaust port is uncovered first, allowing the high pressure gas to escape. Then, even though the piston uncovers the transfer port, no gas enters the cylinder because of the side seals.

5. Before B.D.C. it is possible to open the transfer ort directly to atmosphere, allowing cold air to pass across the top of the piston and purging the cylinder of any remaining exhaust gas.

6. As the cylinder rotates, the exhaust port will be blocked by a heat resistant ceramic seal (e.g. Silicon Nitride) before the compressed

fresh gas is allowed through the transfer port (controlled by Teflon coated sealing rings).

Figs. 24 to 28 inclusive highlight variations to the basic engine design of the second embodiment whereby an amended design according to a third embodiment results.

Fig. 24 is an end section view of the engine similar to that of Fig. 8 but showing a change in spark plug 40 angle relative to the housing so as to reduce the overall diameter of the engine.

Figs. 26 and 27 are vertical and horizontal views respectively similar to that of Figs. 10 and 11 but showing exhaust ports and manifolds more clearly.

Fig. 25 is an end section view similar to Fig. 24 but including four symmetrically spaces retaining grooves adapted to receive and retain springs located between the sealing rings to enhance the sealing efficiency when there is insufficient gas pressure to achieve the same effect. This modification requires additional lubrication. An example of the pressure spring 62 is shown in the inset to Fig. 25. There are four springs for the exhaust and four springs for the inlet. Fig. 31 illustrates one half of the engine crank case of the second embodiment adapted to incorporate two split oil seals placed back to back, the inner seal as an oil seal and the outer seal as a gas seal.

With reference to Figs. 29 and 30 which illustrate the cylinder side sealing ring 22 and the casing side sealing ring 21 in plan view, it can be seen in the cylinder side sealing ring 21 of the third embodiment that the inner most

ring has the pressure spring locating groove in a different position as compared with the second embodiment. This is because these rings are not tensioned against each other (as the other rings are) but tensional against the crank case 7 itself (with suitable locating holes). This follows because the rings are of such small diameter that there is no room for the spring to go all the way across the engine. It is for this reason that the end of the crank case 7 is made round (refer to Fig. 31) to accommodate this sealing ring.

A "main chamber" 63 is defined in the space between the piston and crank case. And "ancillary chamber" 64 is defined in the space around the piston between the larger diameter piston base and the small diameter outer cylinder. To overcome the disadvantage of the volume of the connecting rod reducing the induction capacity of the engine of the third embodiment, the maximum volume of the ancillary chamber 64 is ideally half the volume of the connecting rod between the piston base and the crank case when the piston is at top dead centre (TDC). If the ancillary chamber 64 is made of larger capacity than this then the engine will be effectively super charged.

The piston 8 and the connecting rod can be made as one piece (refer Figs. 15 to 19 of the second embodiment). Alternatively, they can be made separately if it is designed to reduce their total weight. The cylinders 9 can be made in two parts, a larger diameter component and a smaller diameter component, for ease of assembly. The smaller diameter outer

cylinder may have rings like piston rings inserted at its inner end whereby instead of pressing outwards as piston rings normally do they will press against the piston to form a seal for an ancillary chamber. In an alternative position a heat resistant seal can be screwed into position at a location where the outer piston rings never reach.

With reference to Figs. 15 to 19 of the second embodiment, the valve timing for the third embodiment is generally as for the second embodiment except as follows. With particular reference to Fig. 18 the third embodiment differs in that, at low revolutions, there is time for all the compressed, transferred gas to enter the cylinder before the piston closes the transfer port. At higher revolutions some of the compressed gas may be trapped in the transfer port. Thus, there is a pressure release port shown in the casing side sealing ring (refer Fig. 30). This opens after the transfer tract and transfer ports have been closed and allows any residual high pressure gas in the transfer port to be returned by an external pipe or tube to the low pressure inducation tract. Thus, the next time that the piston is in the exhaust phase, no residual fresh charge is exhausted when the air tract is opened.

It will be clear that when the main chamber is performing induction, the ancilliary chamber is performing the transfer function and vice versa.

In the third embodiment the induction/transfer sealing ring, because it is much wider than in the second embodiment, is made ideally in three parts.

Fig. 30, showing an example of the casing side sealing rings 21, shows the connecting tracts 65 between the inner 66 and outer 67 inlet tracts and further illustrates how the three transfer tracts are joined together. These tracts may be machined in the outside of the engine end plates. The vertical section of Fig. 27 and the horizontal section of Fig. 28 show these connecting tracts covered with a sealing plate bolted to the end plates.

The transfer tracts have been shortened to prevent any high pressure gas returning to the following cylinder (which is at a lower pressure) instead of going to the transfer port where it should be. As before, the length of these tracts, the port timing and the like may be altered to suit specific power requirements. The nature of the design of the third embodiment makes it difficult to be run as a diesel engine but with altered porting steam energisation is possible. Similarly, fuel injection can be utilised instead of a carburetter based system.

The ignition timing may be controlled from the crank shaft side of the engine with two sets of contacts placed 180° part. Each contact will control one part of opposed cylinders and the timing may be varied by an automotive centrifugal advance mechanism.

As regards the extra volume created by the use of a double diameter piston, if the total required capacity increase is accomplished by the larger main chamber, then the ancilliary chamber can be opened to atmosphere to reduce the pumping losses and aid cooling.

The vertical section and horizontal section views of a fourth embodiment of the engine are shown in Figs. 32 and 33.

In this embodiment, the arrangement is such that it is possible to turn the engine by rotating the cylinders by taking the drive from the cylinder block. With this modification, as illustrated in Figs. 32 and 33, there is insufficient room to connect the carburettors directly to the main inlet tracts so they are connected to the ancillary inlet tracts. This is allowable as both tracts are in communication with each other.

The primary features which differentiate the fourth embodiment from the earlier embodiments include the longer main bearing bolted to the end plate which is opened out to accept the longer main bearing as well as the lengthened crank case with an oil seal. The driving gear is bolted to the crank case and held by a key way (not shown). The engine oil still drains through the crank case but instead of going to the drain tract (not shown in Figs. 32 and 33) it exits into the drive case to lubricate the gears. It will drain back to the sump via an external pipe (not shown). A slot must be cut into the outer main bearing case between the bolts to allow the mating gear to mesh with the driving gear and the complete transmission must be contained in an oil tight casing.

The outer main bearing case has been shown somewhat off centre for ease of bolting to the existing bolt holes.

In use engine drive can be taken from the shaft e.g. for conventional car-type applications. Alternatively, the

drive can be taken from the crank case gear or the shaft for motorcycle applications.

Fig. 34 illustrates an arrangement for porting the exhaust gases from the engine to the external environment. The arrangement can be used with any one of the embodiments illustrated so far. The exhaust sealing plate 68 may be sunk into the end plate/side plate or alternatively spaced away from it and secured by bolts. A short exhaust tube 69 may be attached to the plate by welding or screwing. Enough clearance should be allowed around the exhaust tube 69 to allow the free passage of cooling air. This reduces the contact area between the exhaust sealing plate and the end plate to a minimum thus reducing heat transfer and distortion. The main exhaust pipe (not shown) may be clamped to the protruding exhaust tube.

The above describes only some embodiments of the present invention and modifications obvious to those skilled in the art can be made thereto without departing from the scope and spirit of the present invention.

It is to be appreciated that port timing may be changed as also the tract length and positioning (with relative changes to the sealing ring orifice) in accordance with experimental data obtained in relation to parameters such as gas velocity, port shape and the length of the engine and the desired speed limit.

By positioning the combustion chamber to the side of the cylinders, the engine can be adapted for diesel or steam

operation. Use as a steam engine will require port relocation. All sealing rings would need to be ceramic coated for steam engine operation.

INDUSTRIAL APPLICABILITY

The invention may be applied to an internal combustion engine, a heat engine operating on internal or external combustion, hydraulic or pneumatic motors and steam engines of the rotary type.

CLAIMS

1. A motor of the rotary type including a cylinder block rotatably mounted within a cylinder housing, a shaft journalled for rotation in said housing, piston members rotatably supported on the shaft for rotary motion in the cylinder housing as the shaft and the cylinder block rotate and a plurality of cylinders arranged to define chambers between the housing and the piston members that vary in volume, in sequence, in response to the relative movement between the piston members and the housing.

2. The motor of claim 1 wherein said cylinder block is rotatably geared to said cylinder housing.

3. The motor of claim 2 wherein said cylinder block is rotatably geared to said cylinder housing by epicyclic gears of ratio 2:1.

4. The motor of claim 3 wherein said epicyclic gears comprise two idler gears.

5. The motor of claim 1 wherein timing of entry of combustion gases into said chambers is controlled by a transfer port arrangement located for communication with said chambers by a side entry.

6. The motor of claim 5 further including a rotary valve for control of transfer of combustion gases from an underside of said piston members into said chambers.

7. The motor of claim 1 including exhaust valves mounted on a peripheral portion of said cylinder housing, one valve for each pair of opposed cylinders and wherein the location of said valves is offset so as to match with an offset pair

8. The motor of claim 5 including dual transfer tracts comprising a first and second transfer tract wherein said second transfer tract is joined to said first transfer tract by a groove machined in said cylinder housing.

9. The motor of claim 8 wherein whilst an individual one of said piston members is descending on a power stroke the corresponding exhaust port is uncovered allowing high pressure gas to escape but wherein side seals prevent exhaust gas from entering said chambers via said transfer port.

10. The motor of claim 9 wherein means are provided whereby said transfer port is open directly to atmosphere allowing cold air to pass across the top of individual ones of said piston members thereby purging said volume of any remaining exhaust gases.

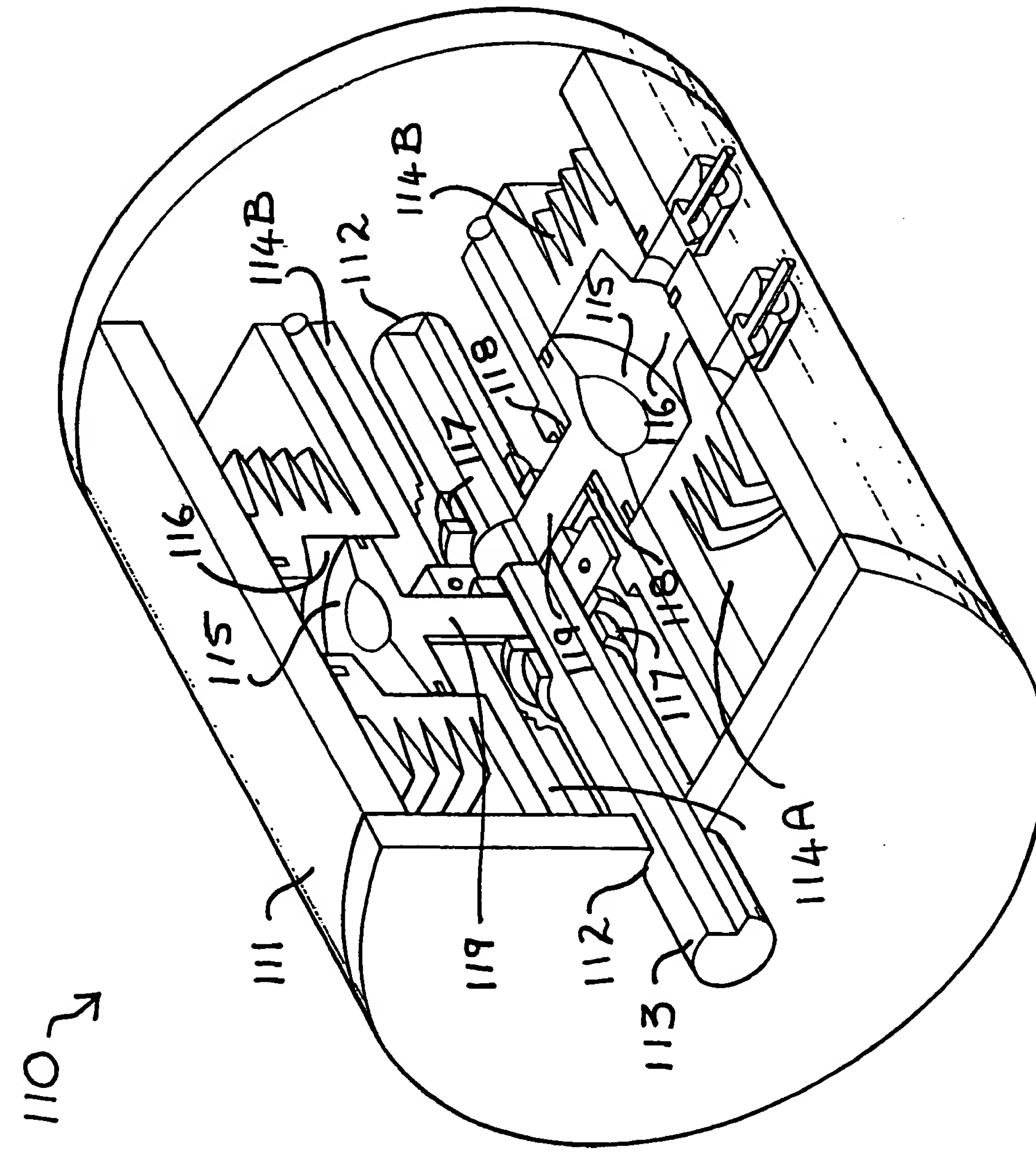

FIG. 1

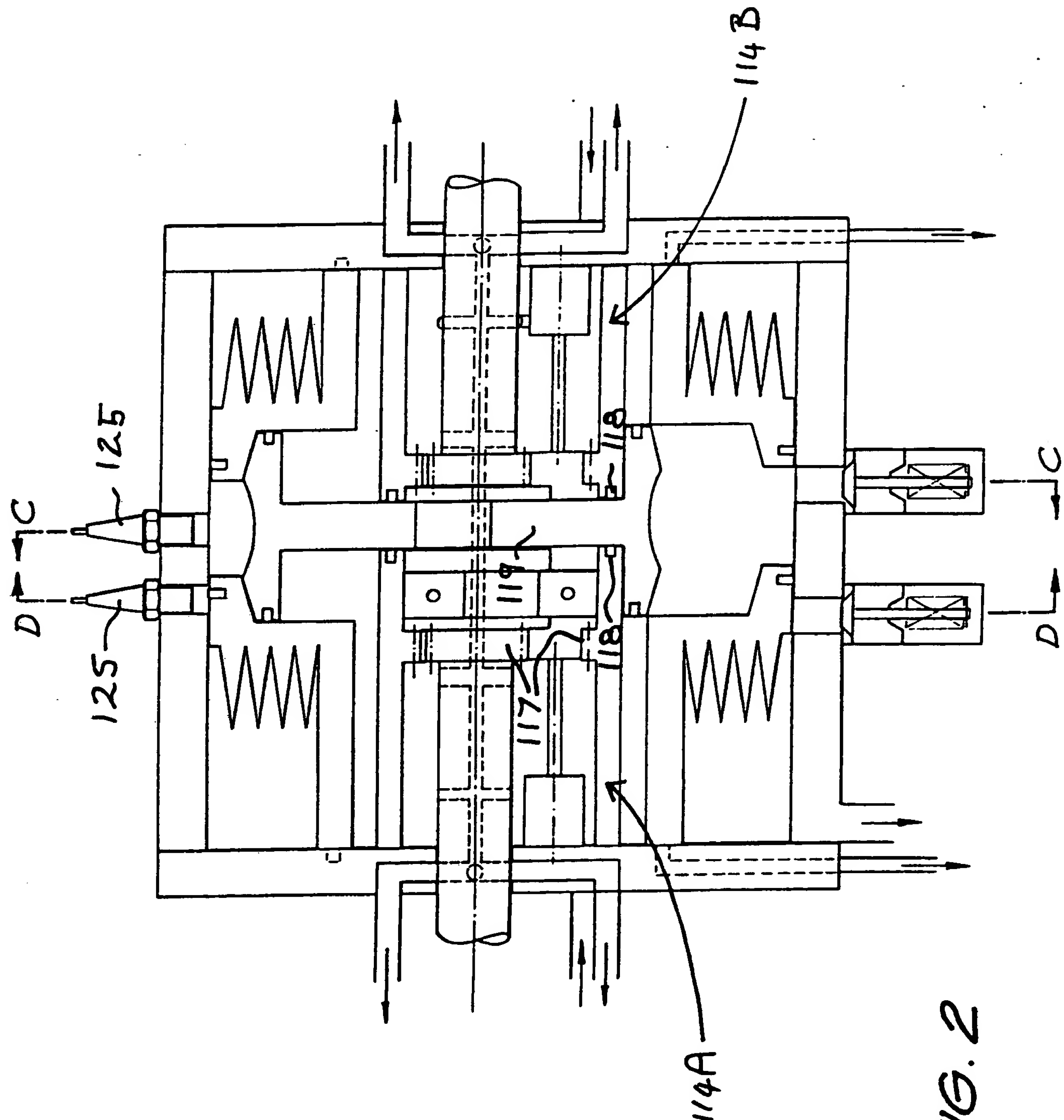

FIG. 2

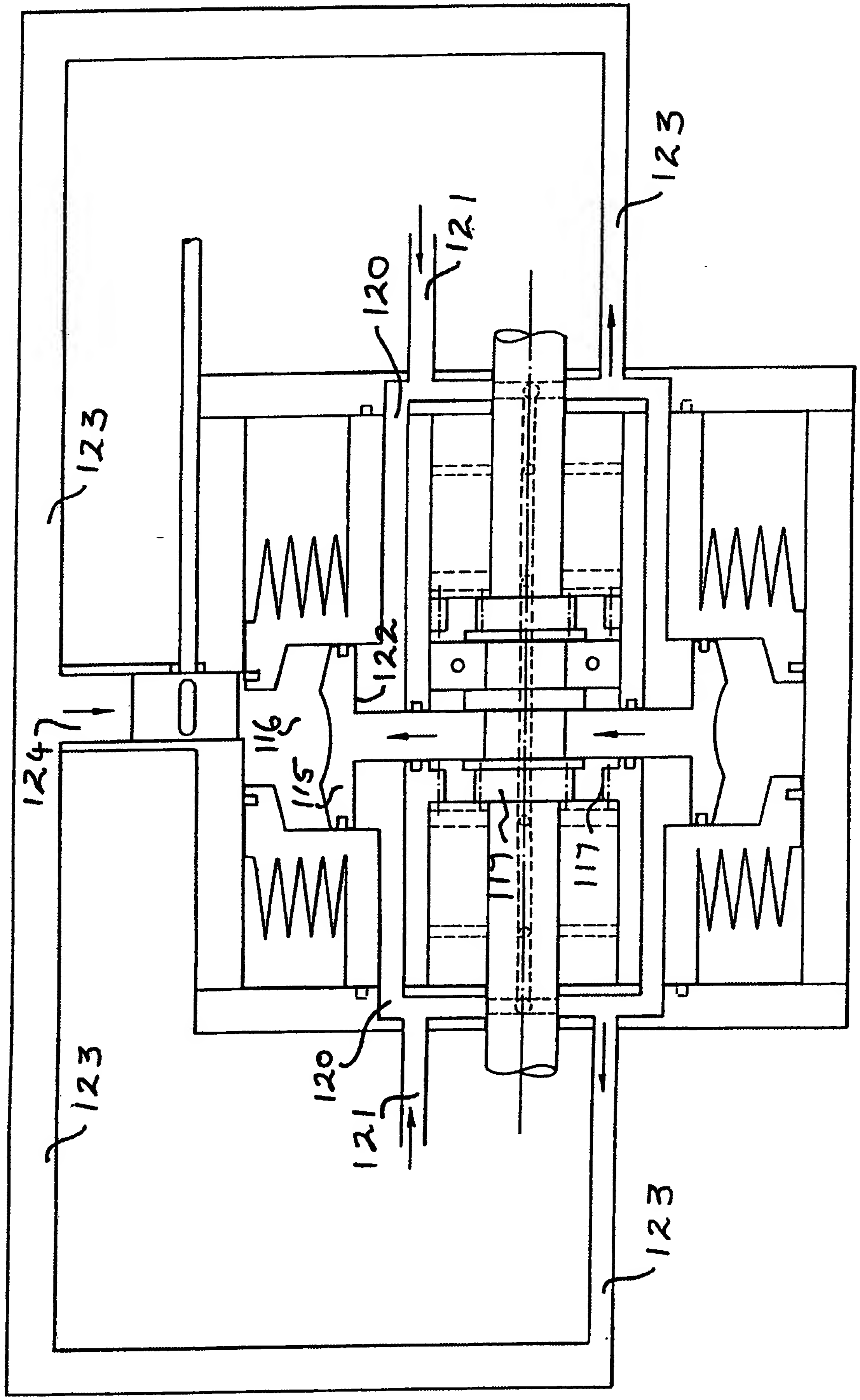

FIG. 3

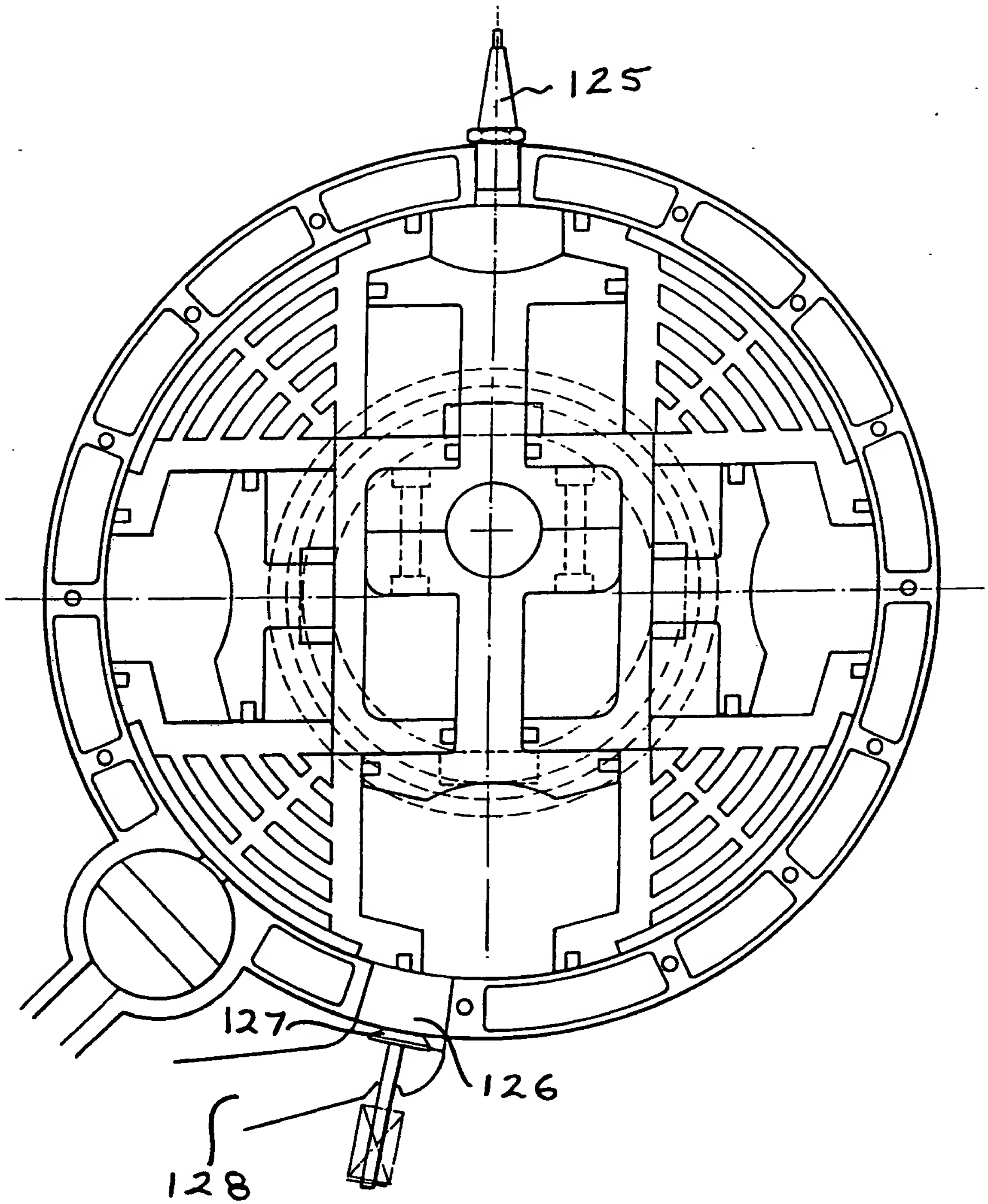

FIG. 4

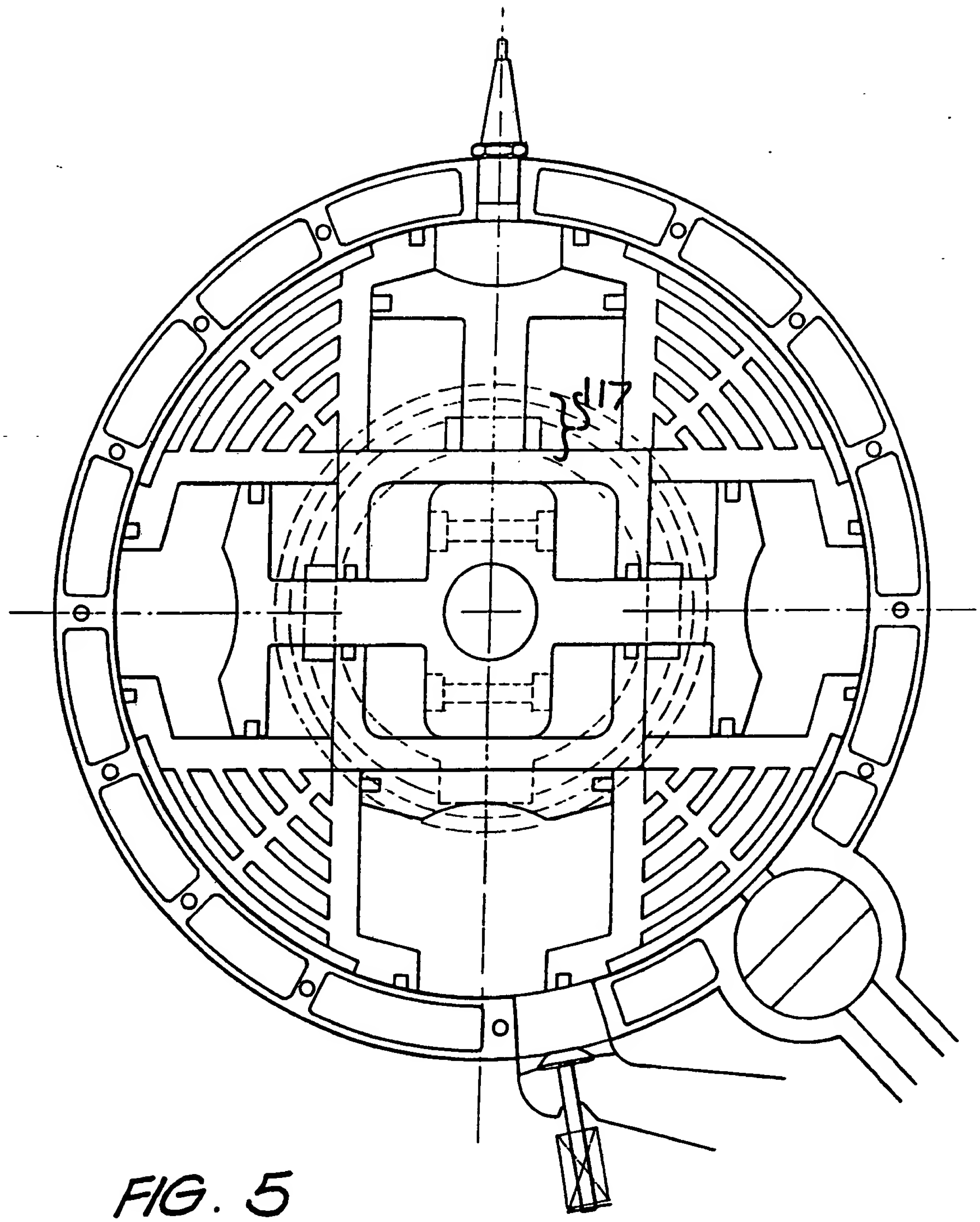

FIG. 5

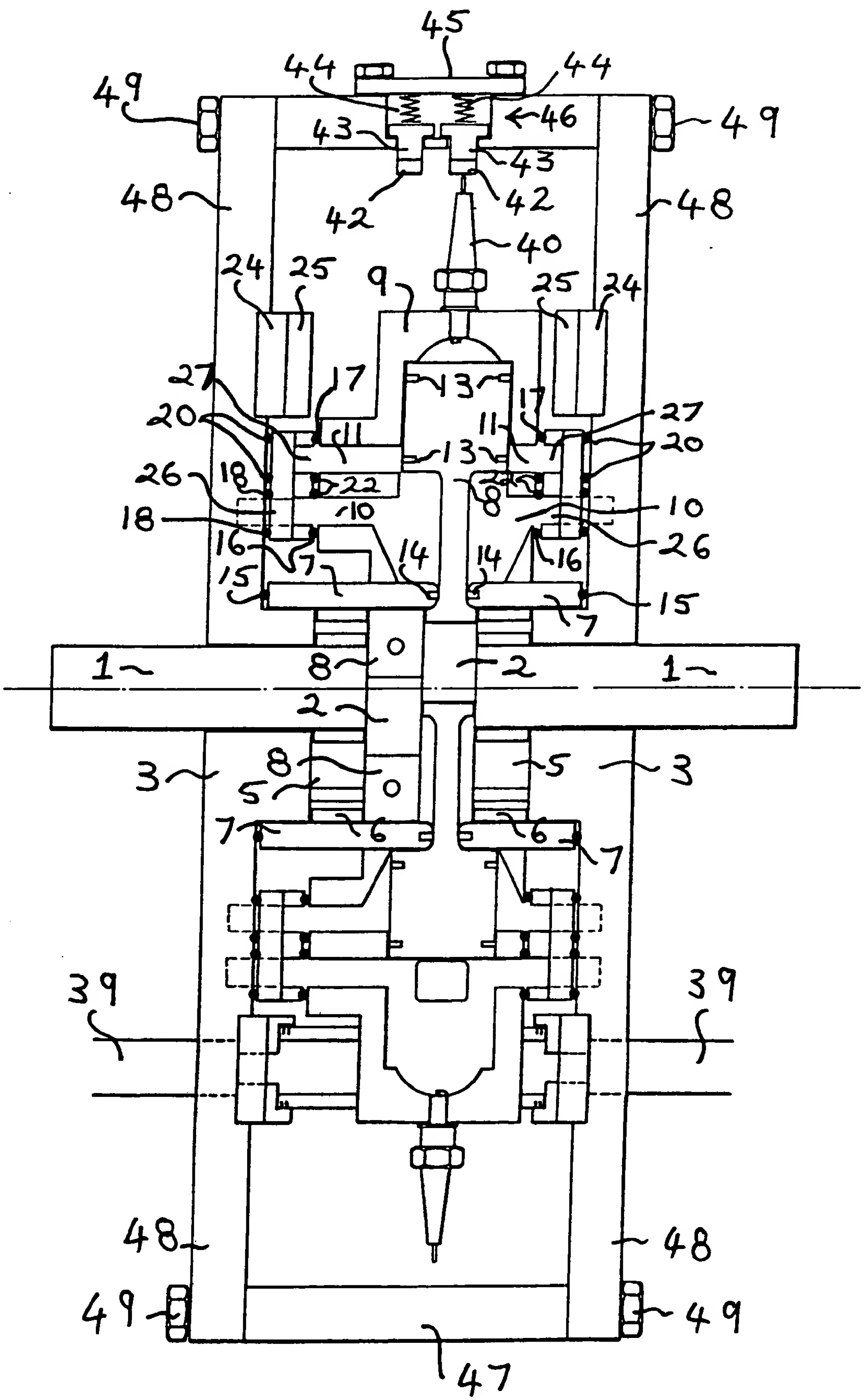
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FIG. 6

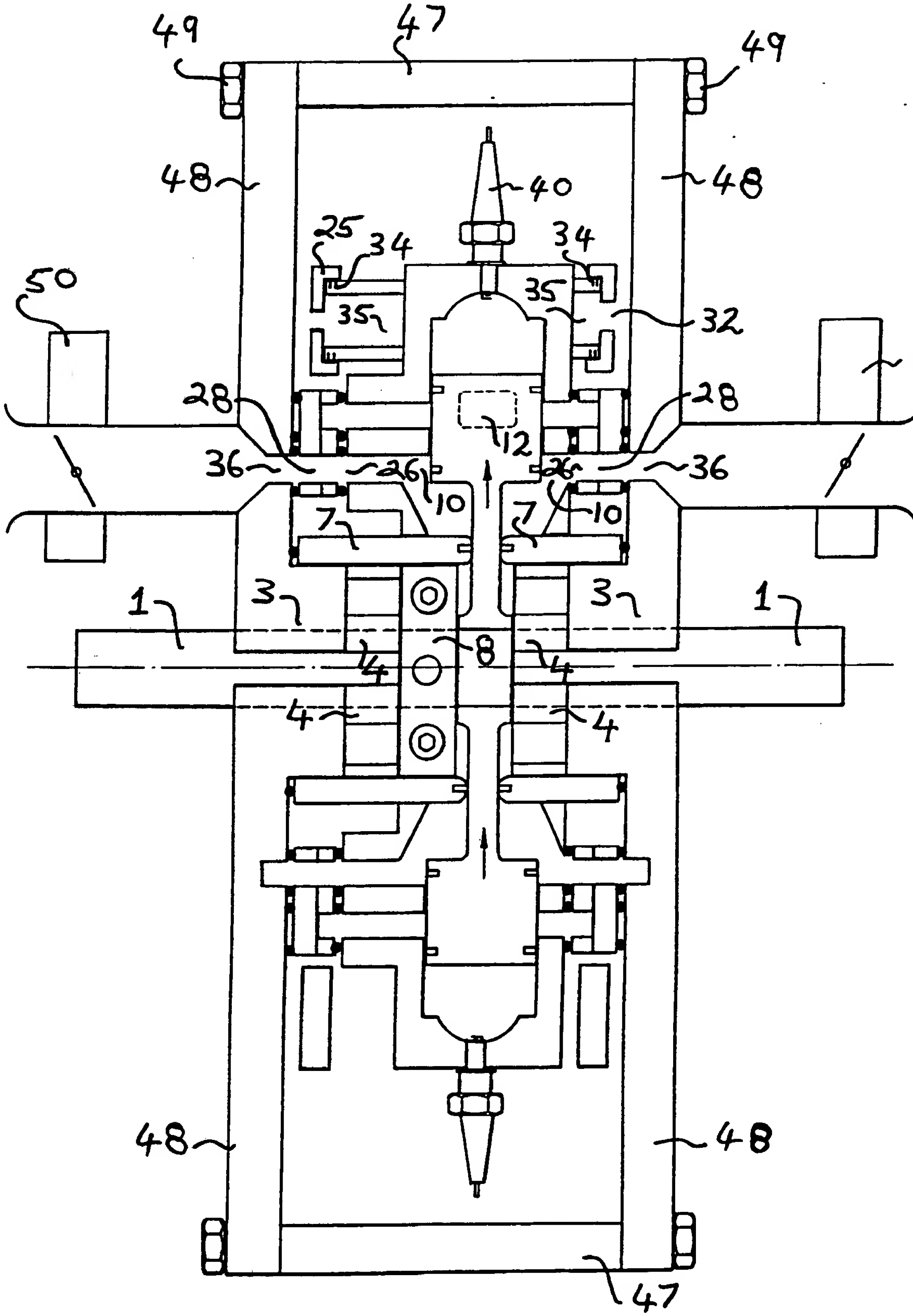
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FIG 7

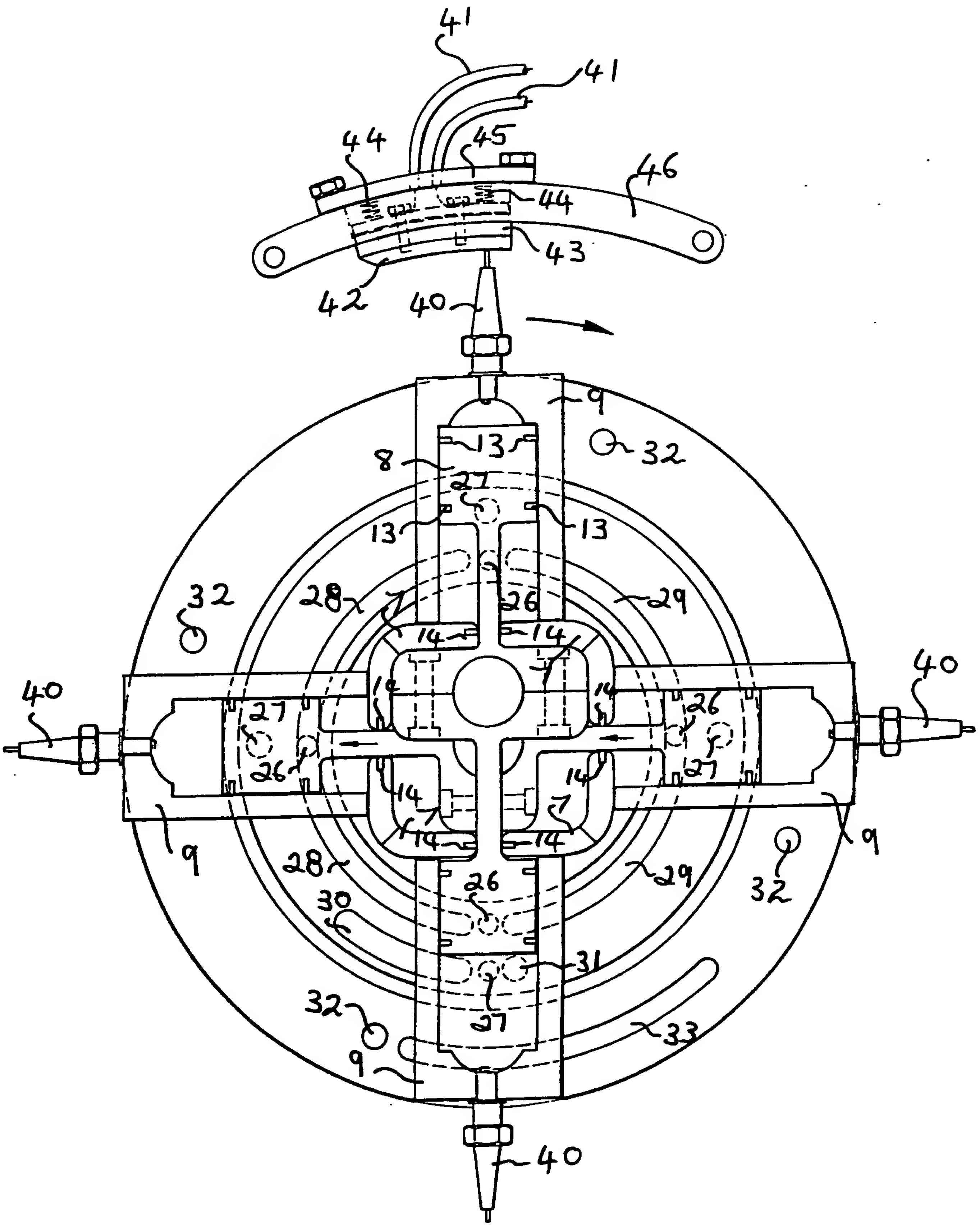
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FIG. 8

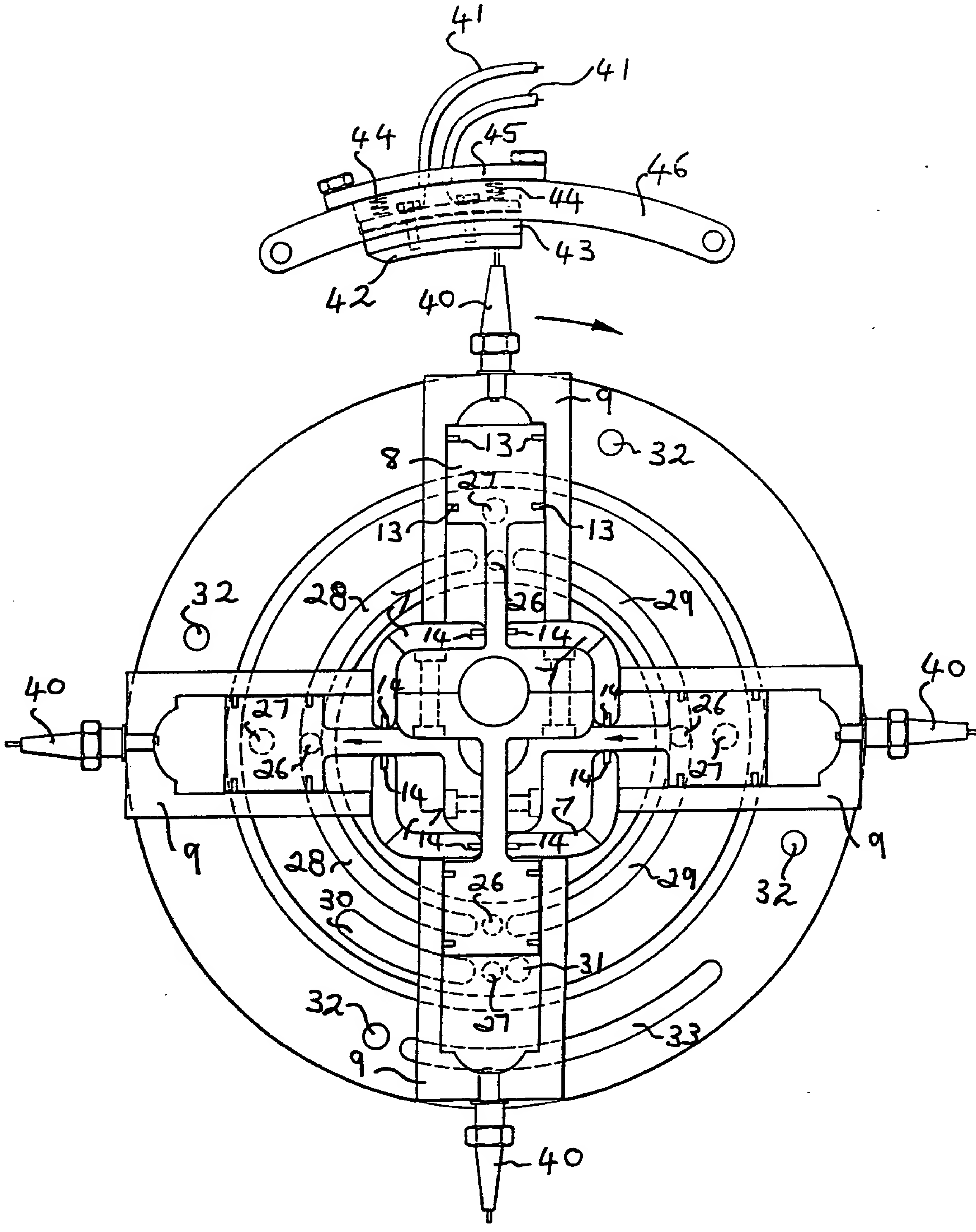
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FIG. 9

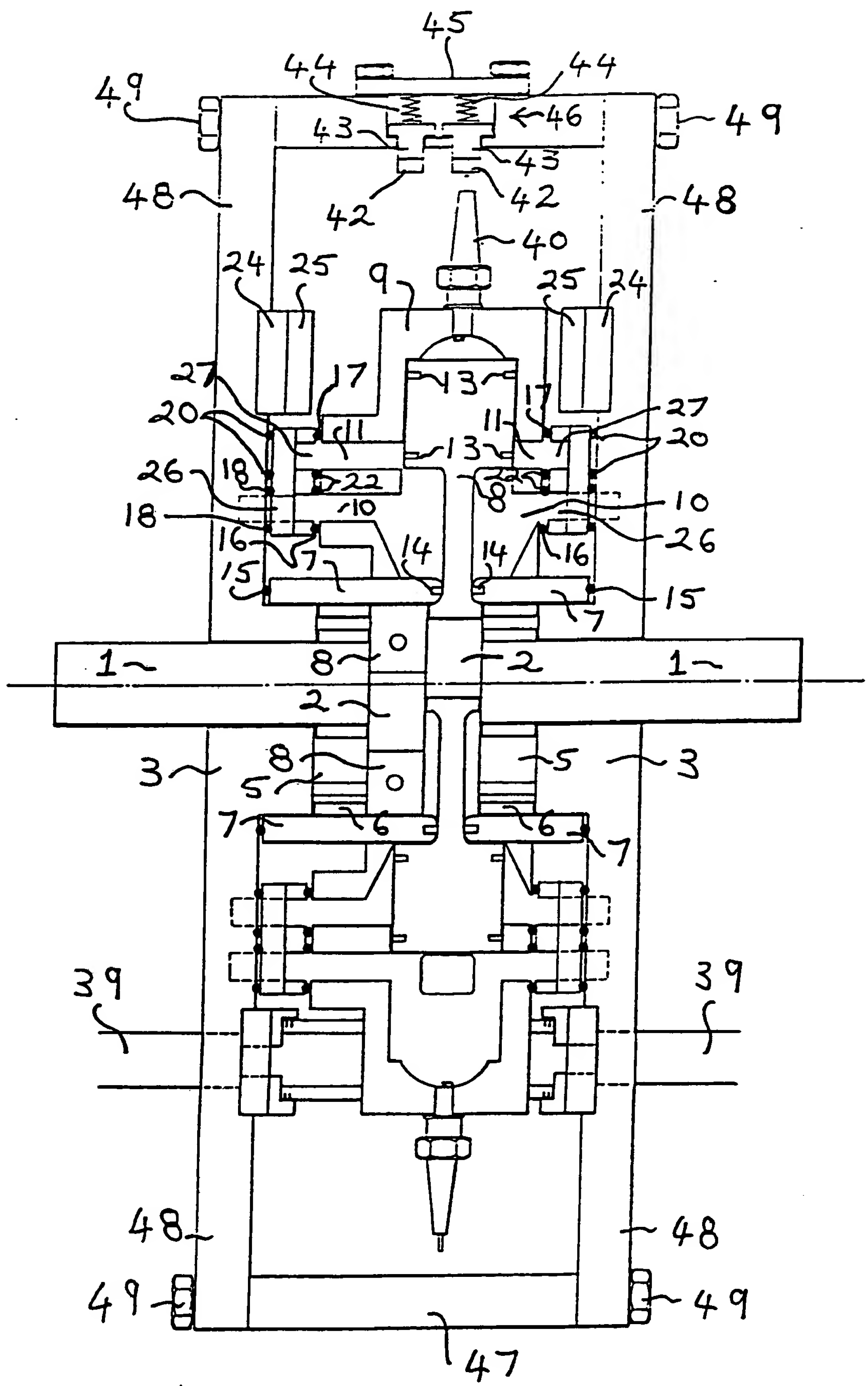
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FIG. 10

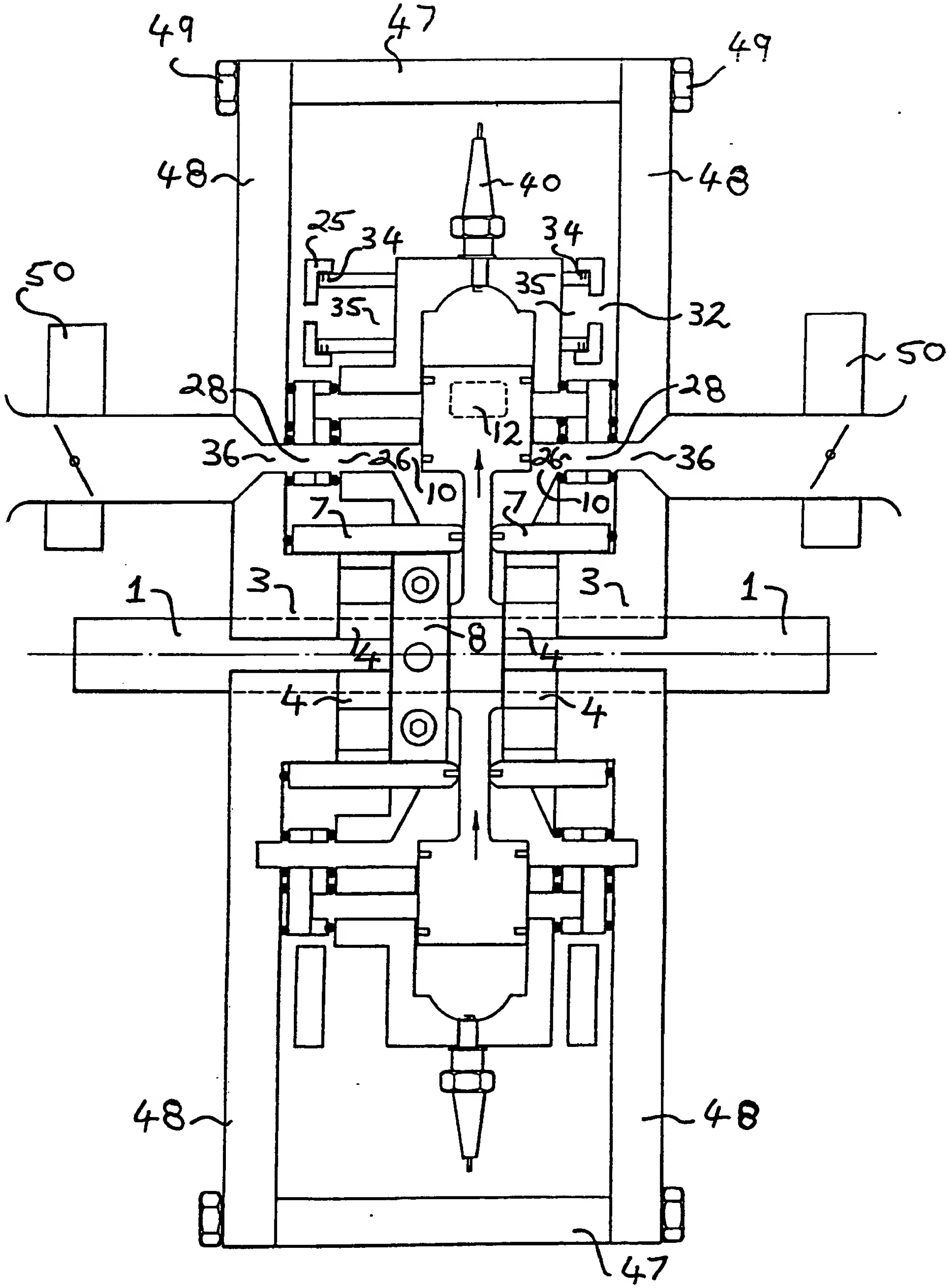
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FIG. 11

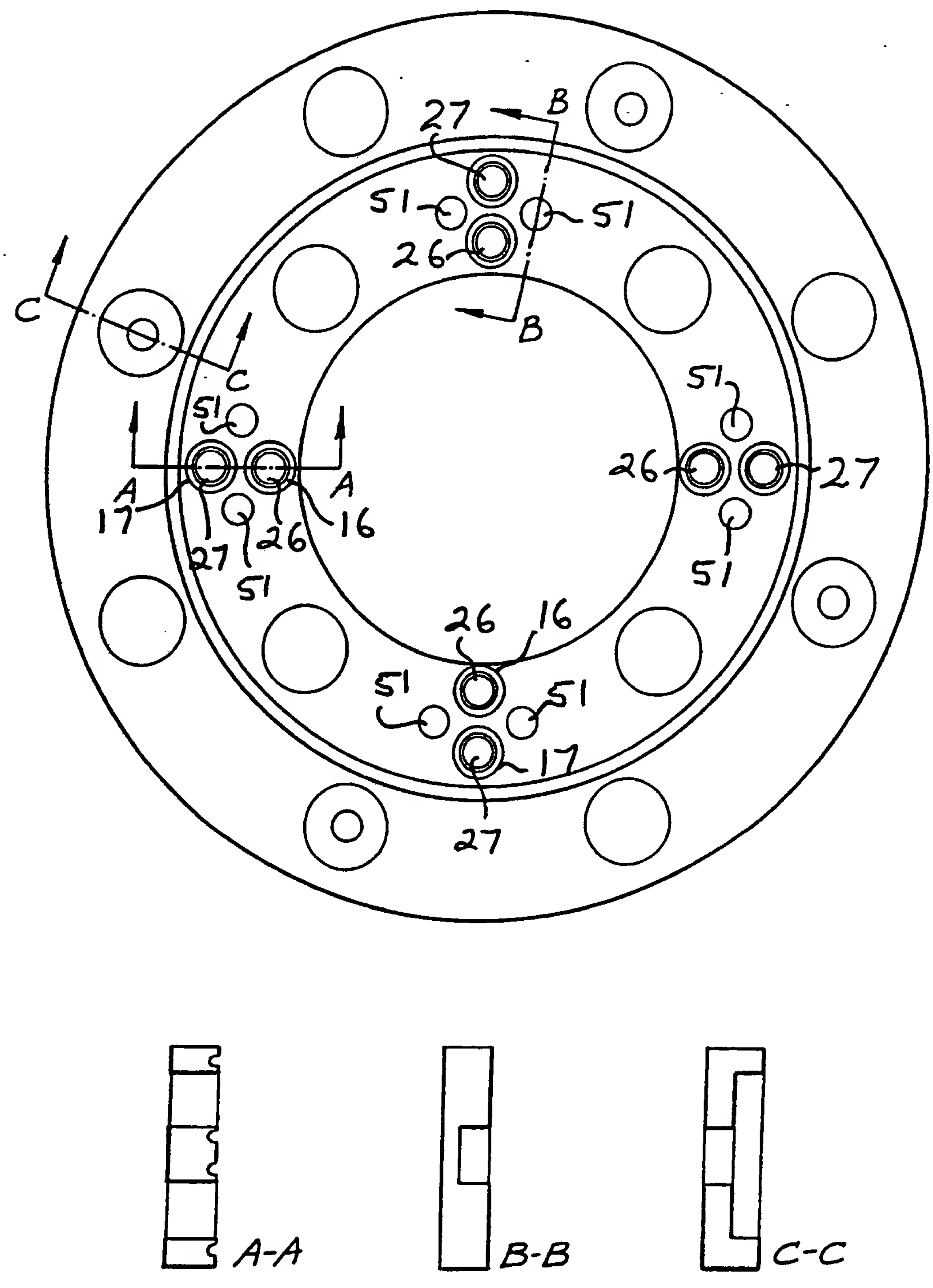
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FIG. 12

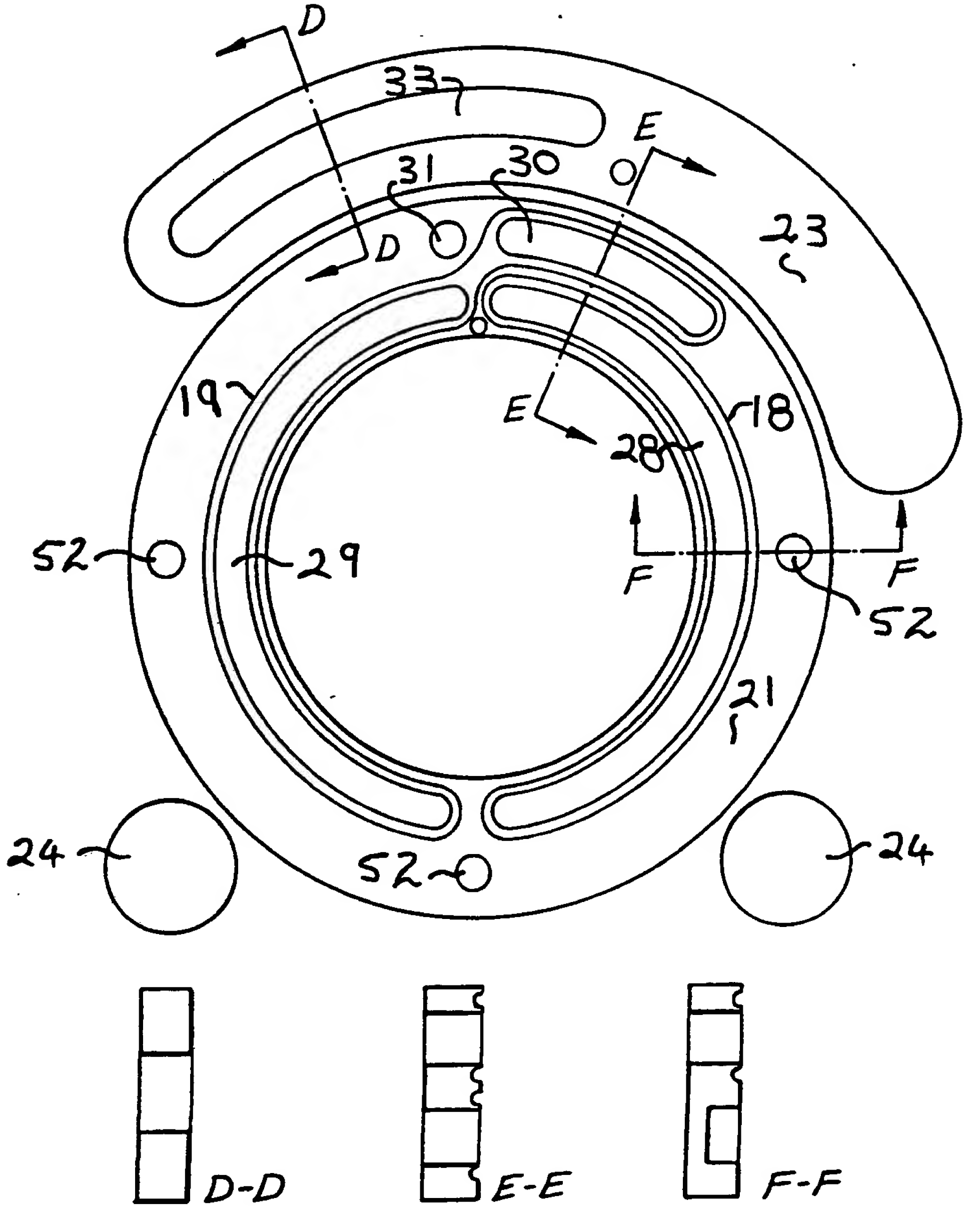


FIG. 13

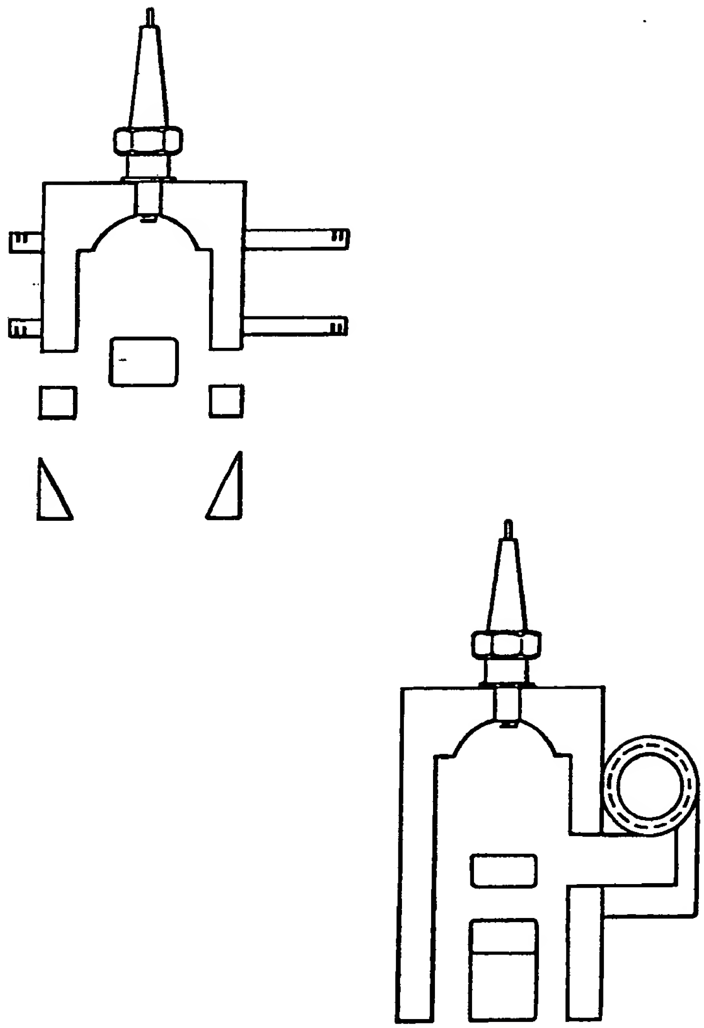


FIG. 14

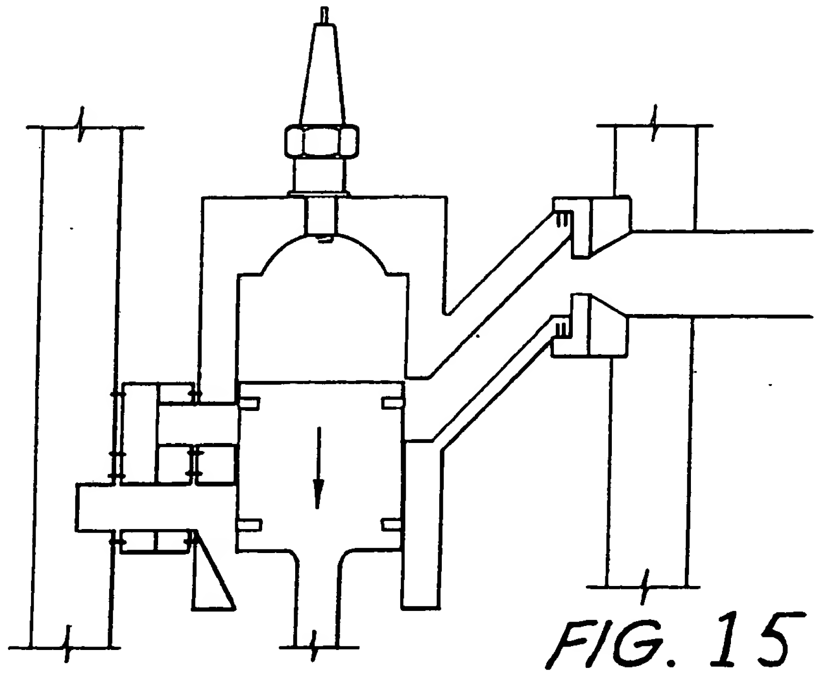


FIG. 15

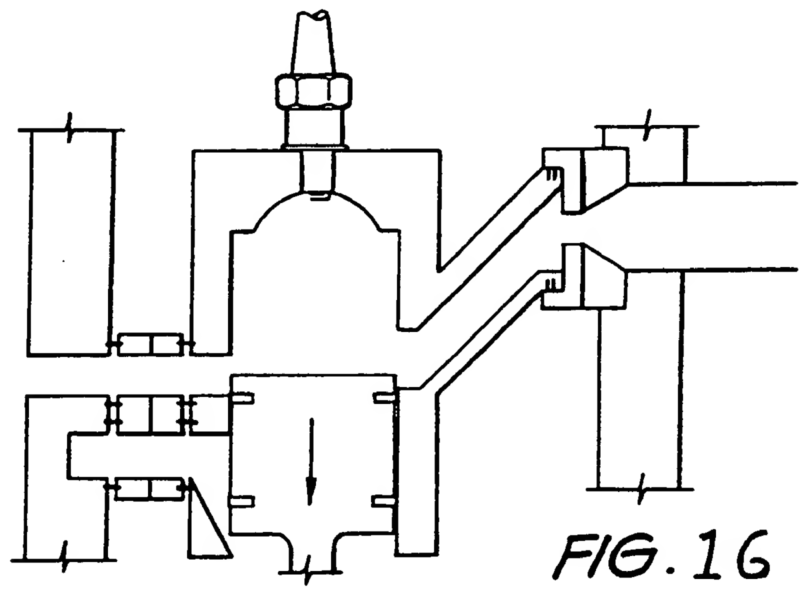


FIG. 16

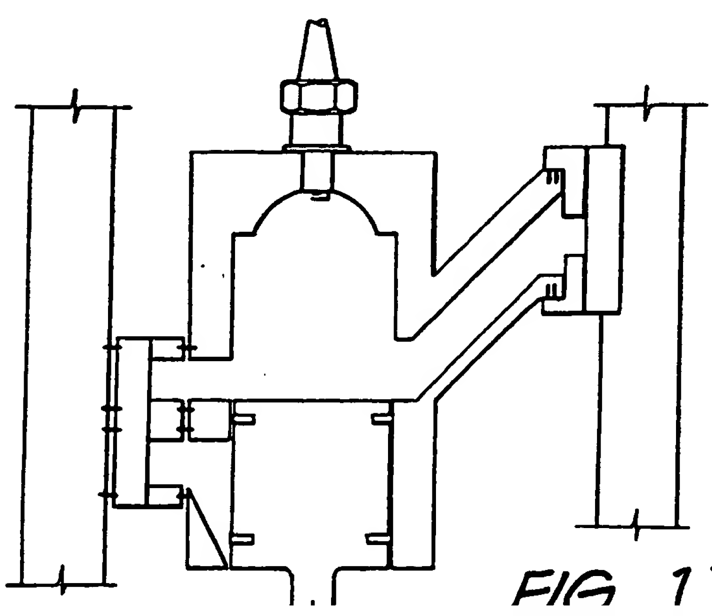


FIG. 17

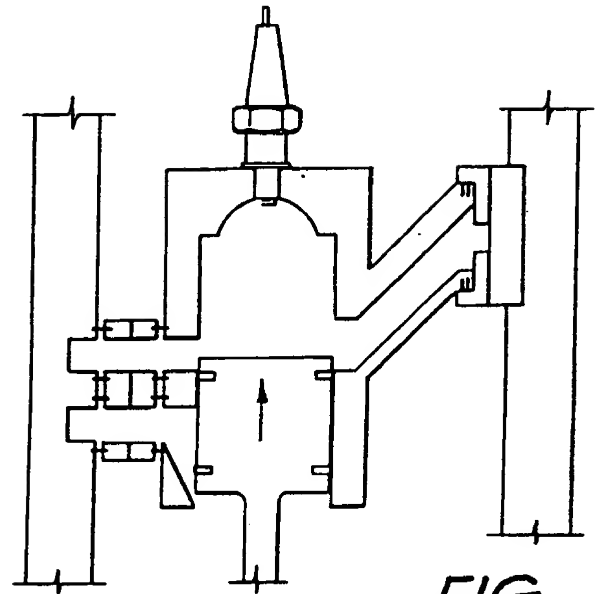


FIG. 18

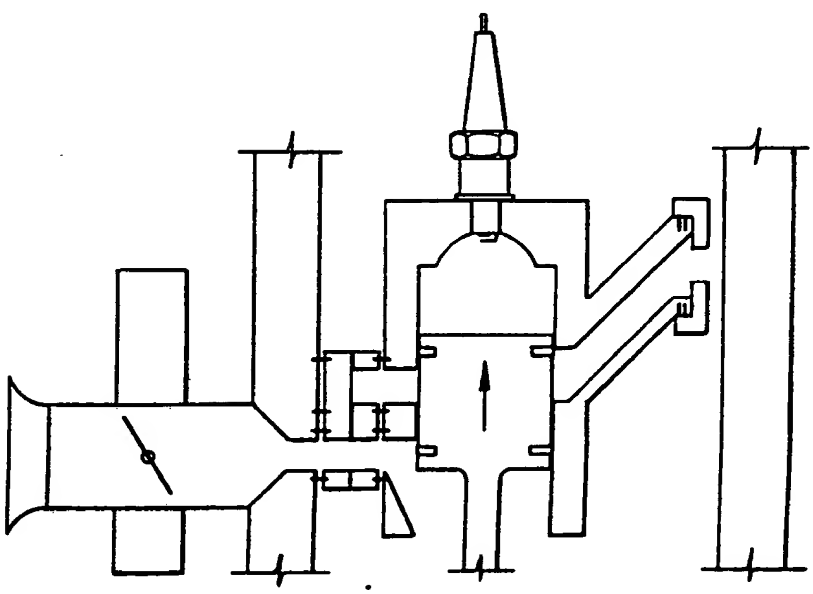


FIG. 19

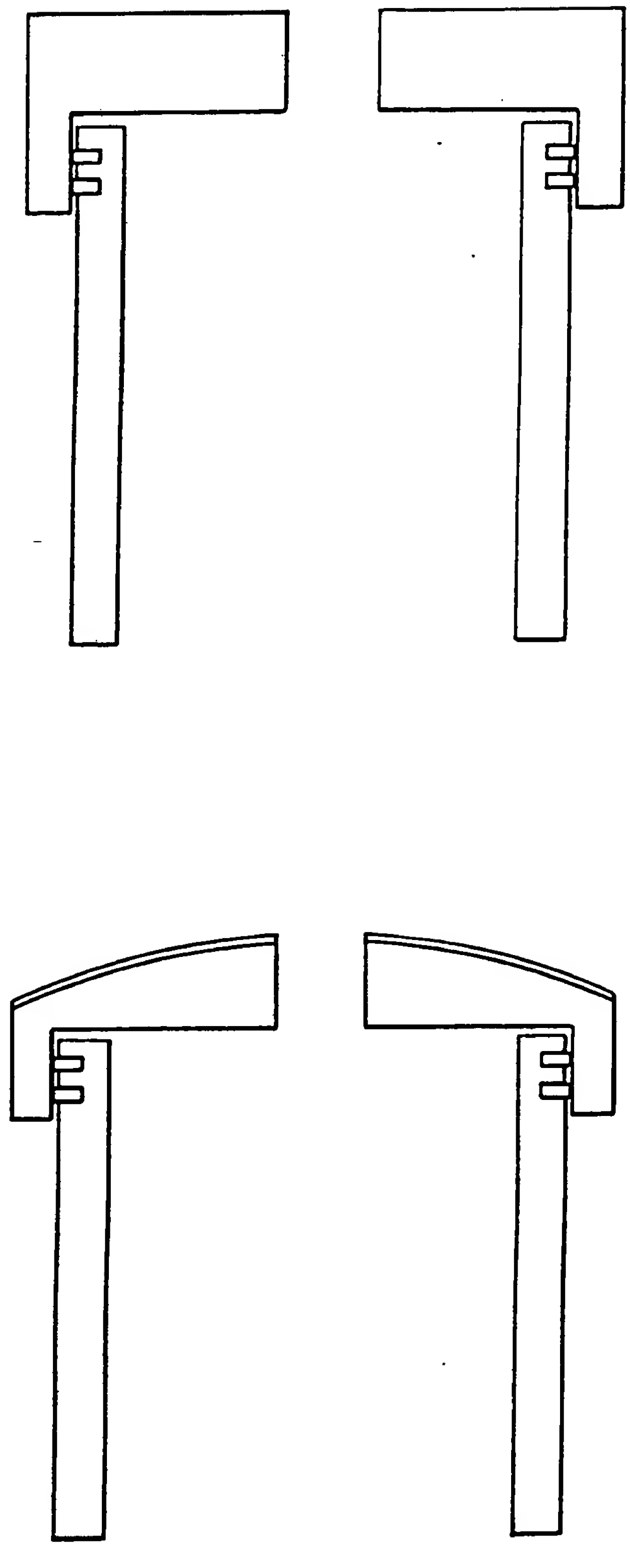


FIG. 20

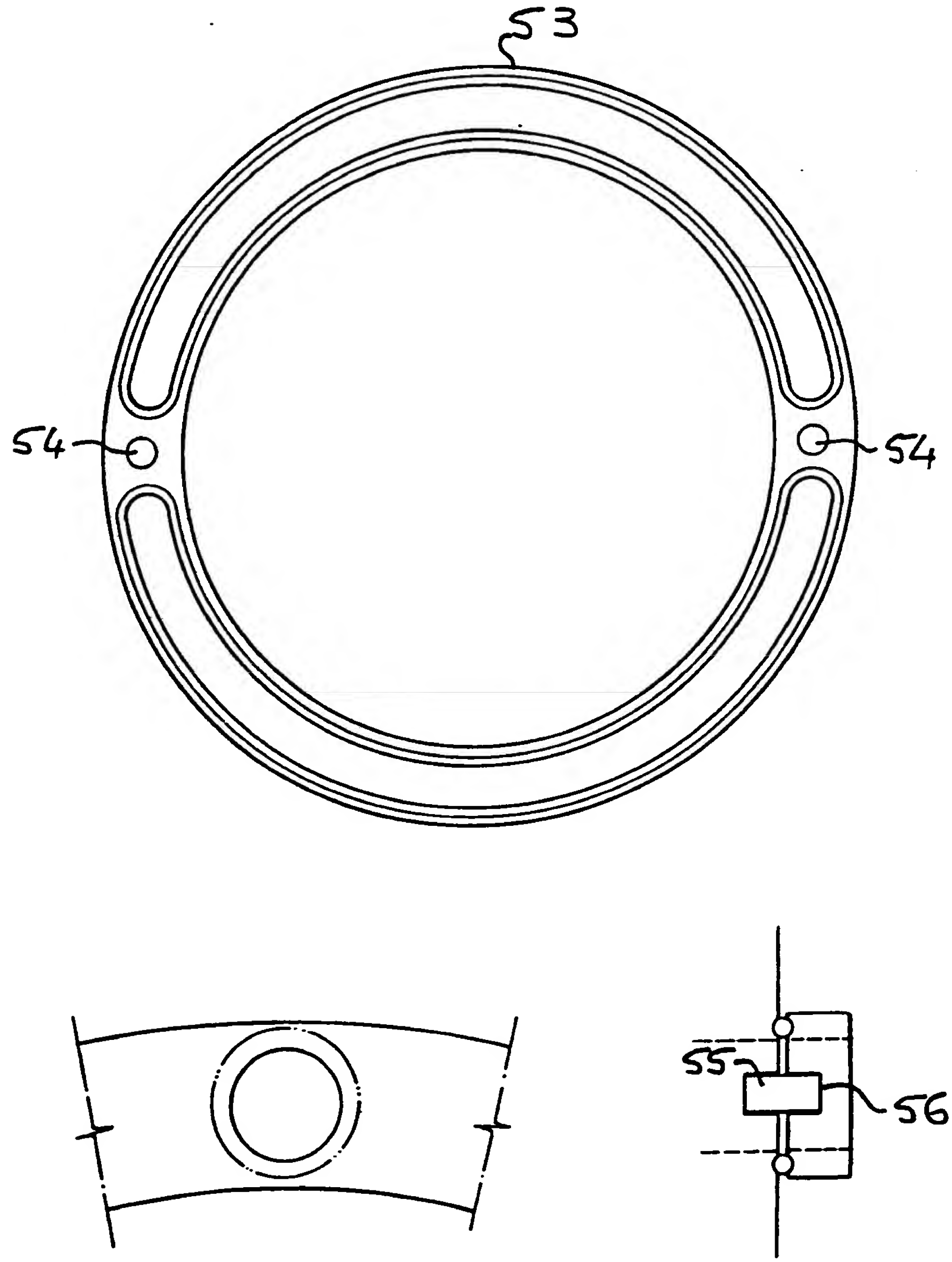


FIG. 21

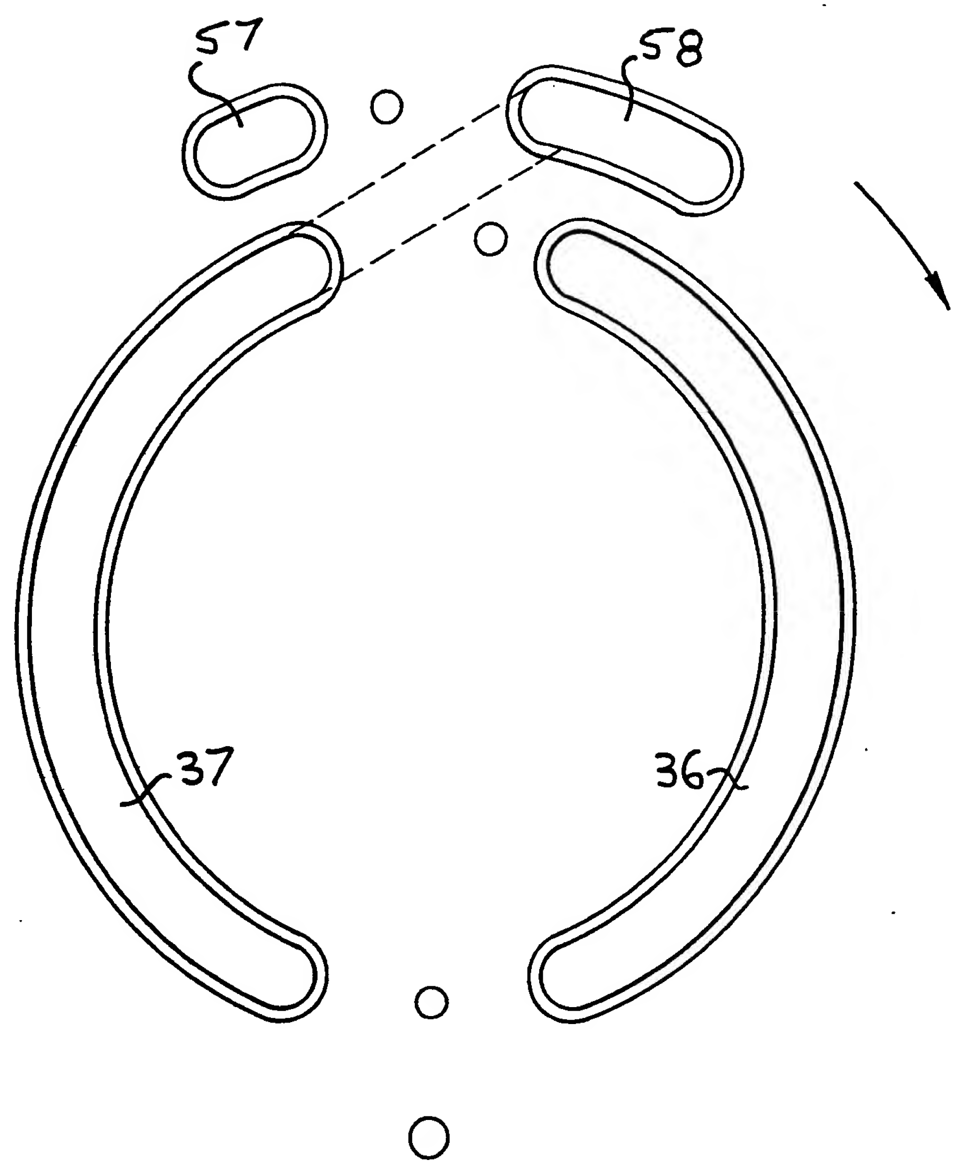


FIG. 22

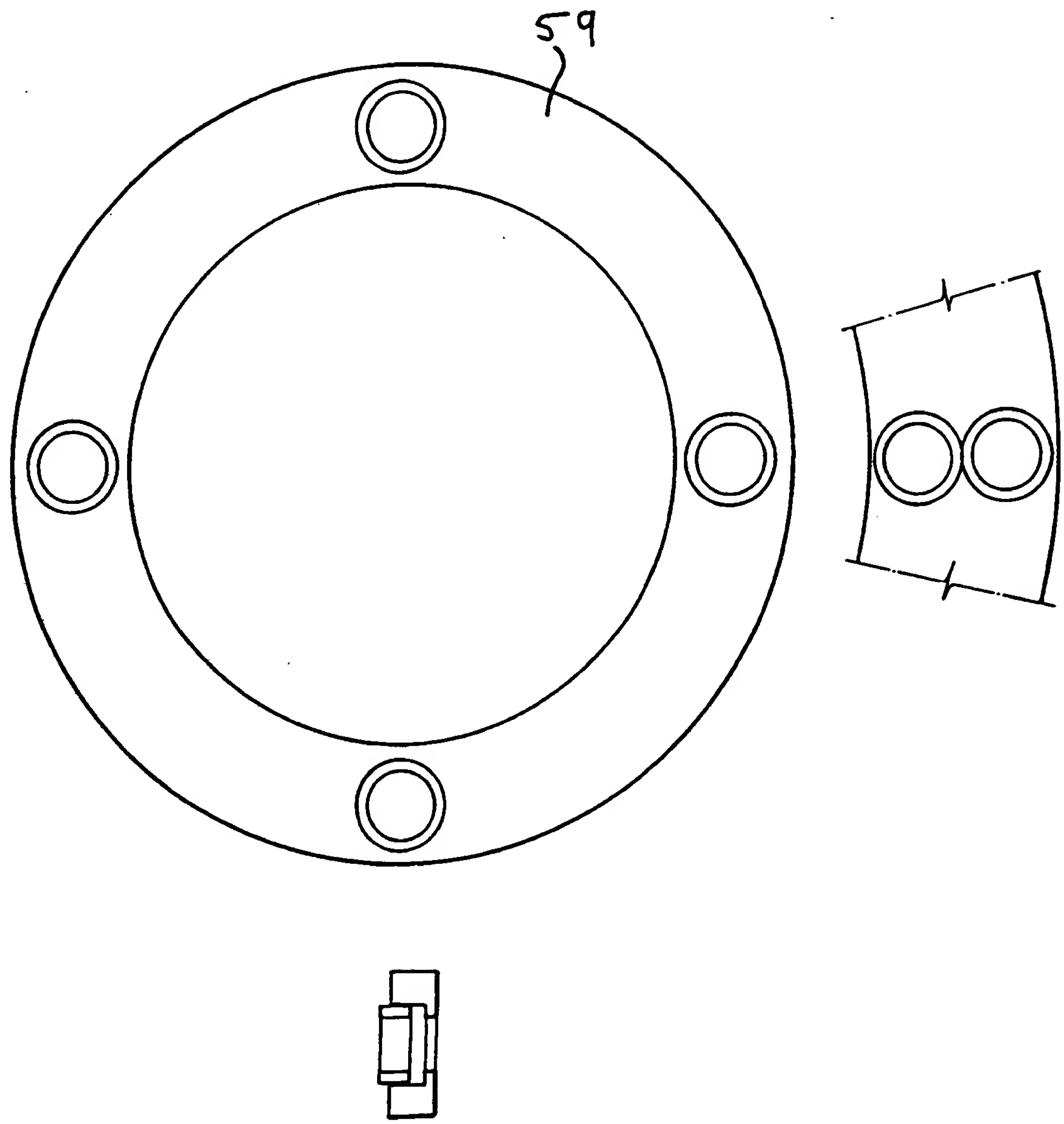


FIG. 23

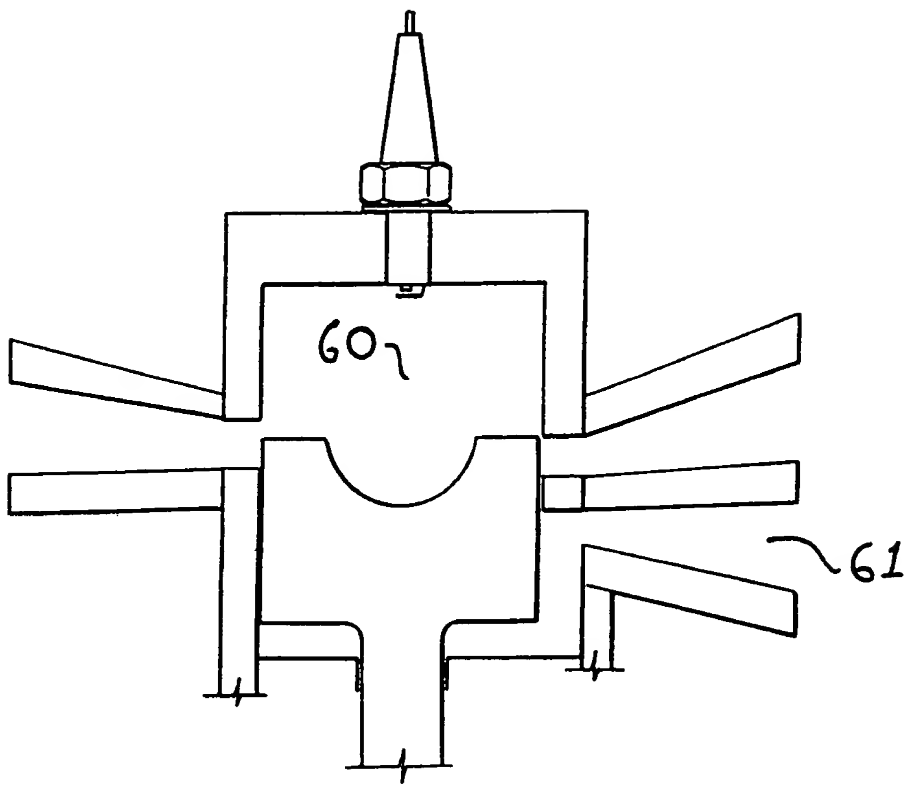


FIG. 24

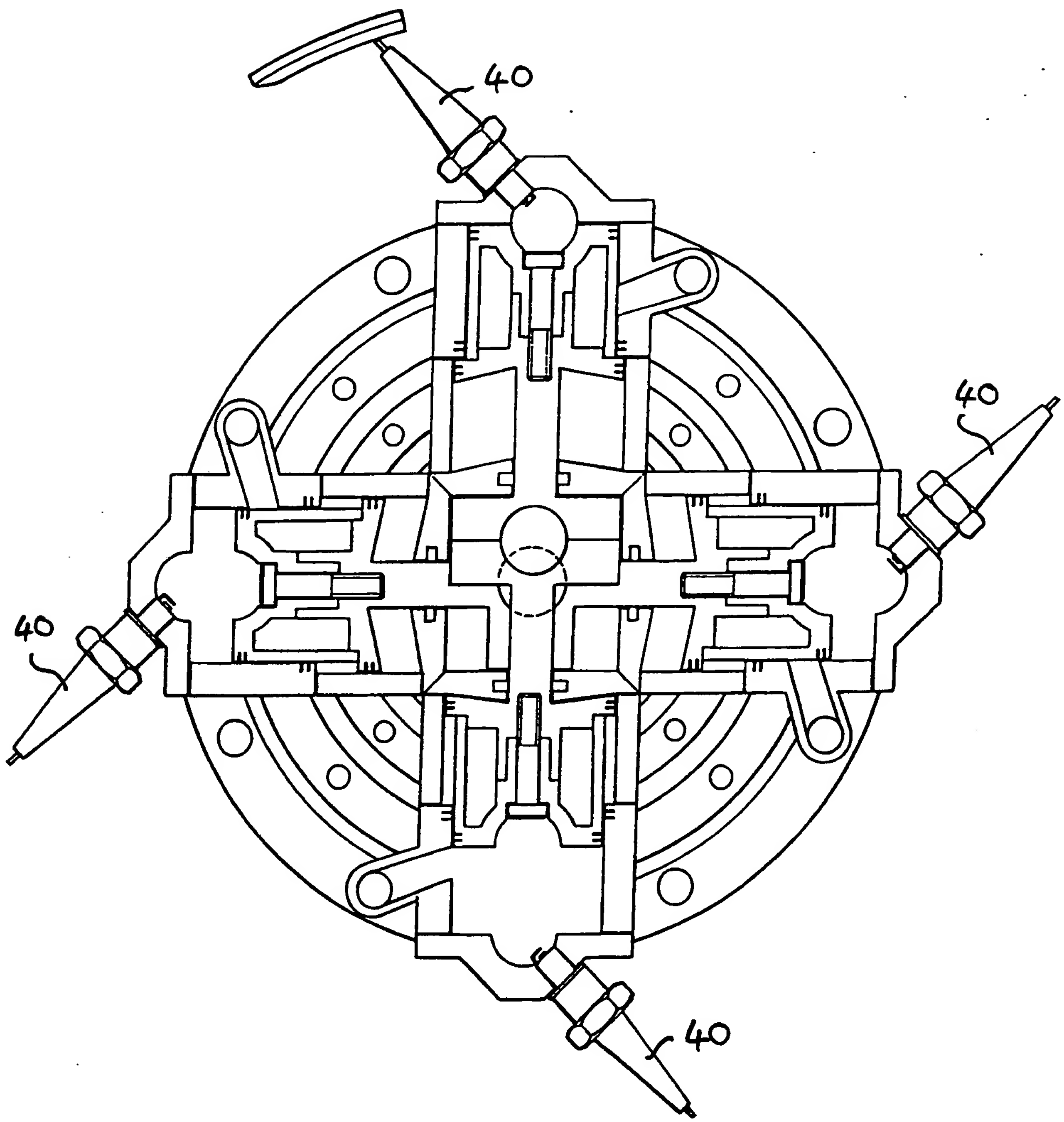


FIG. 25

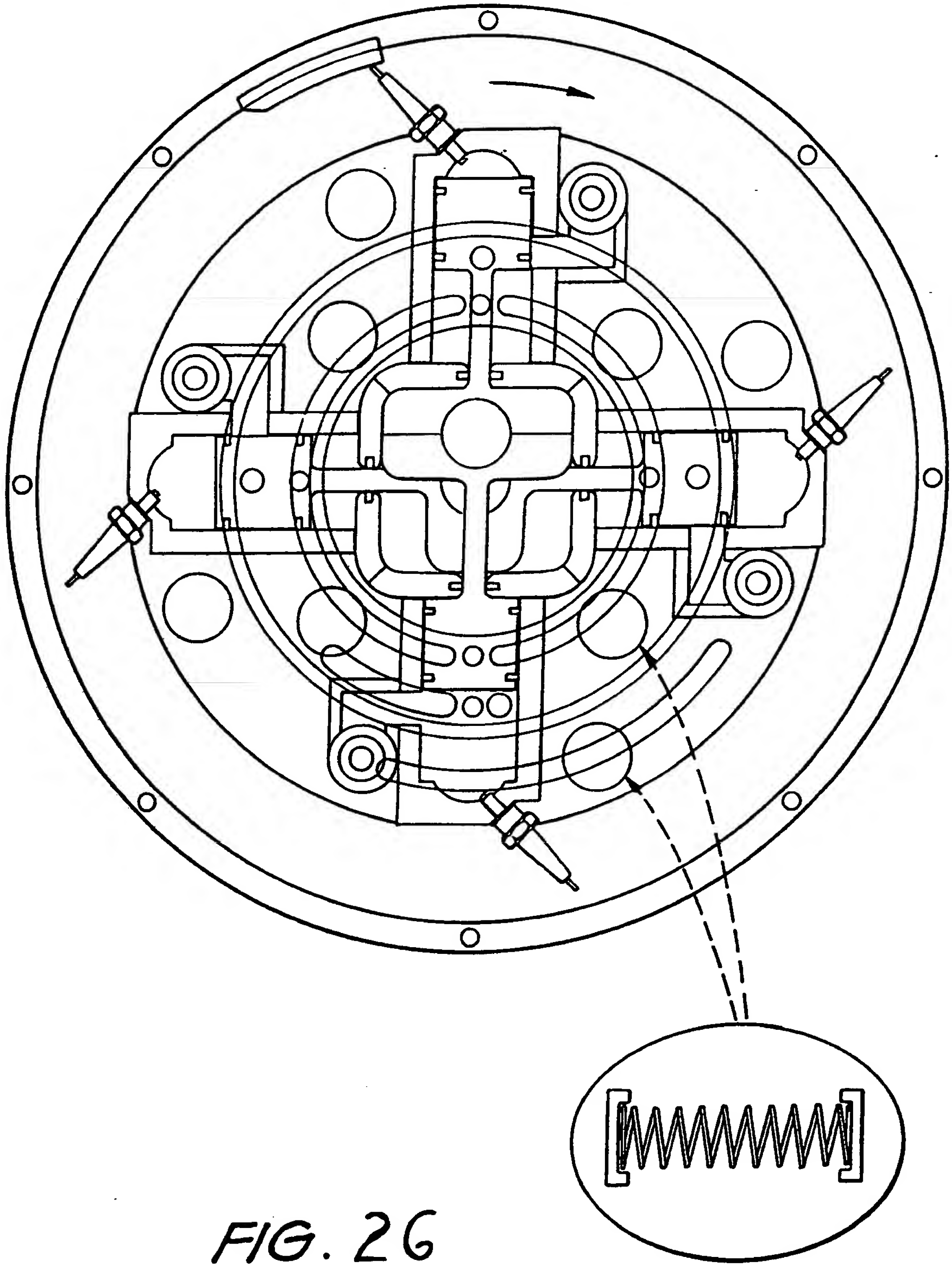


FIG. 26

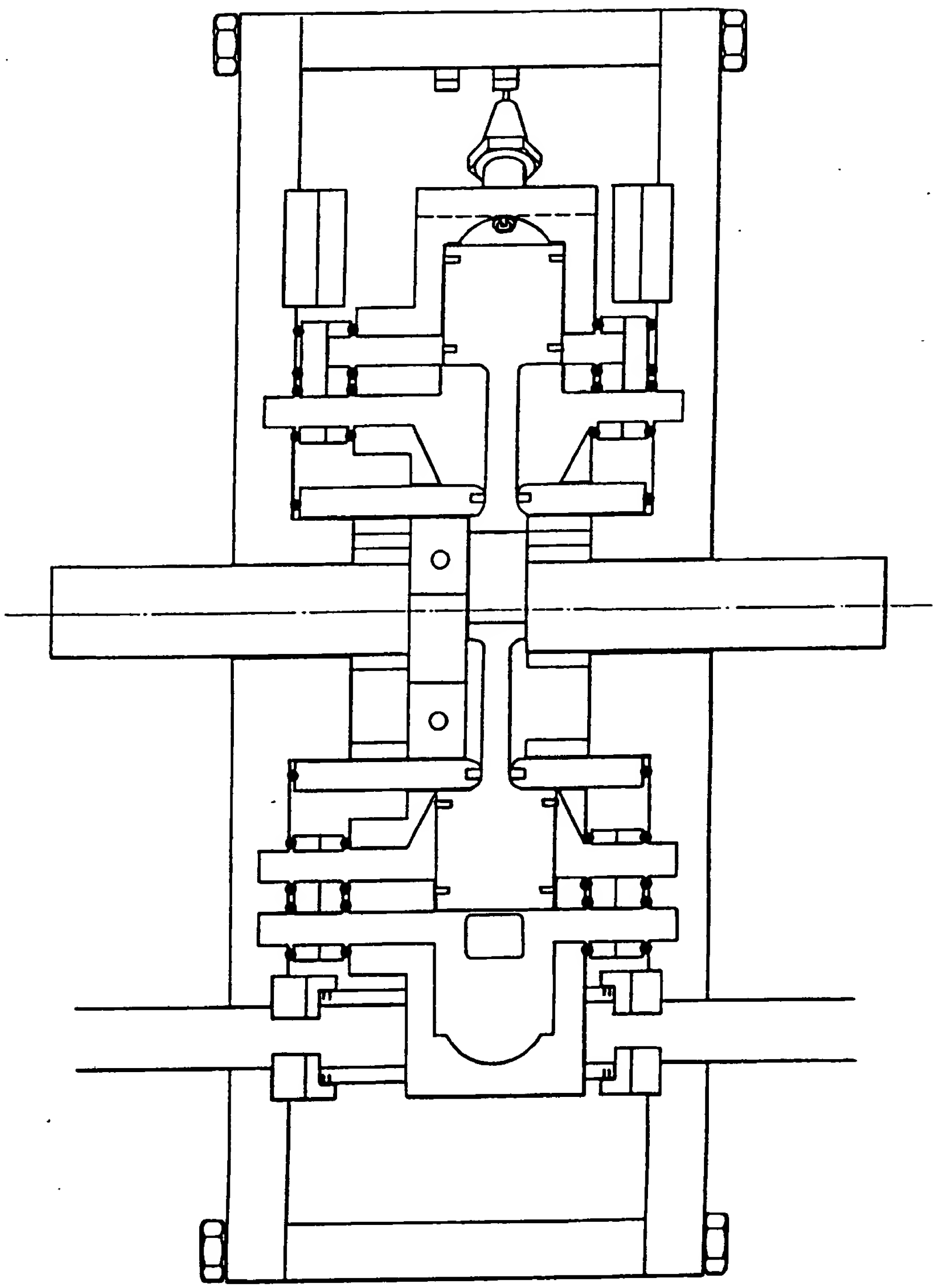


FIG. 27

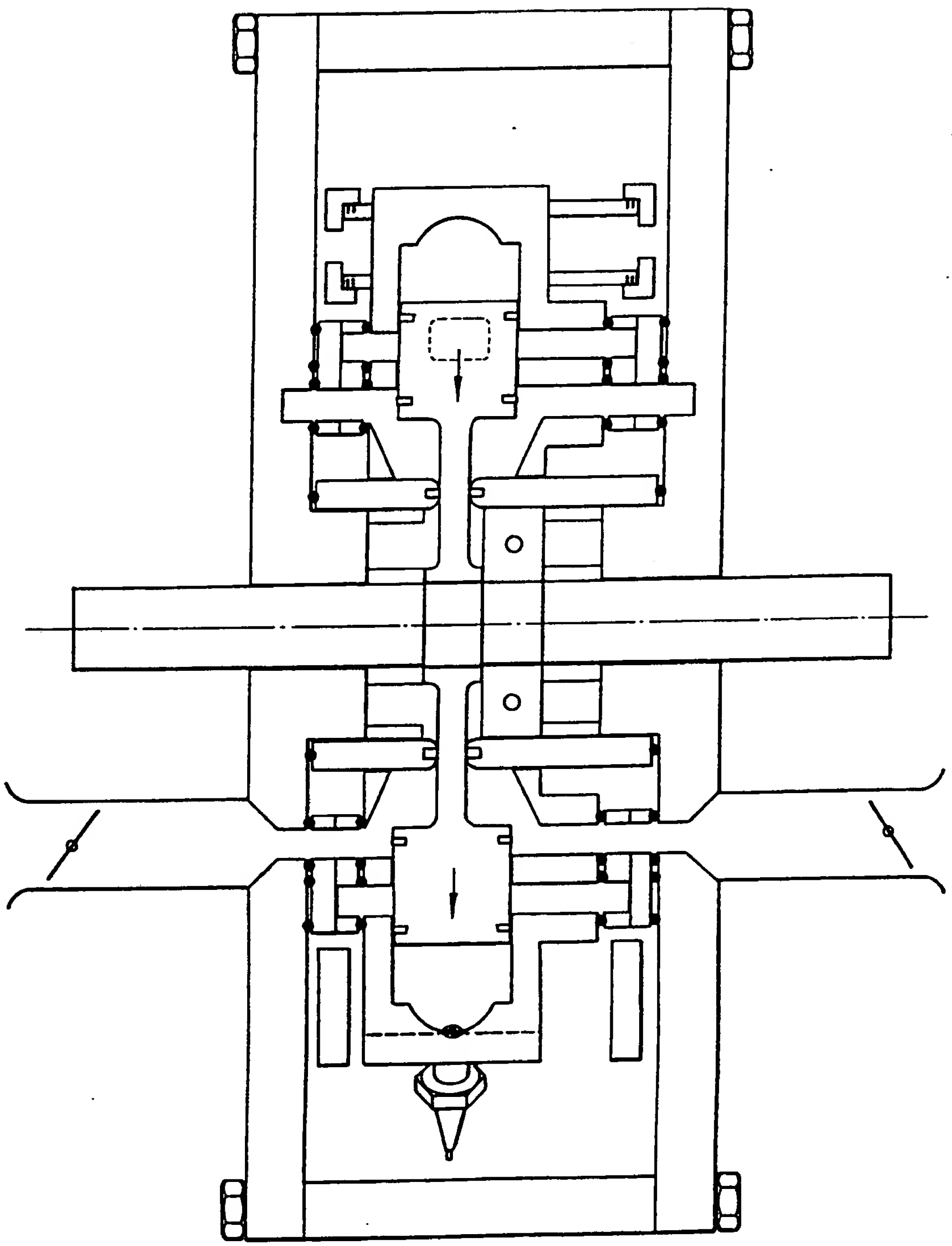


FIG. 28

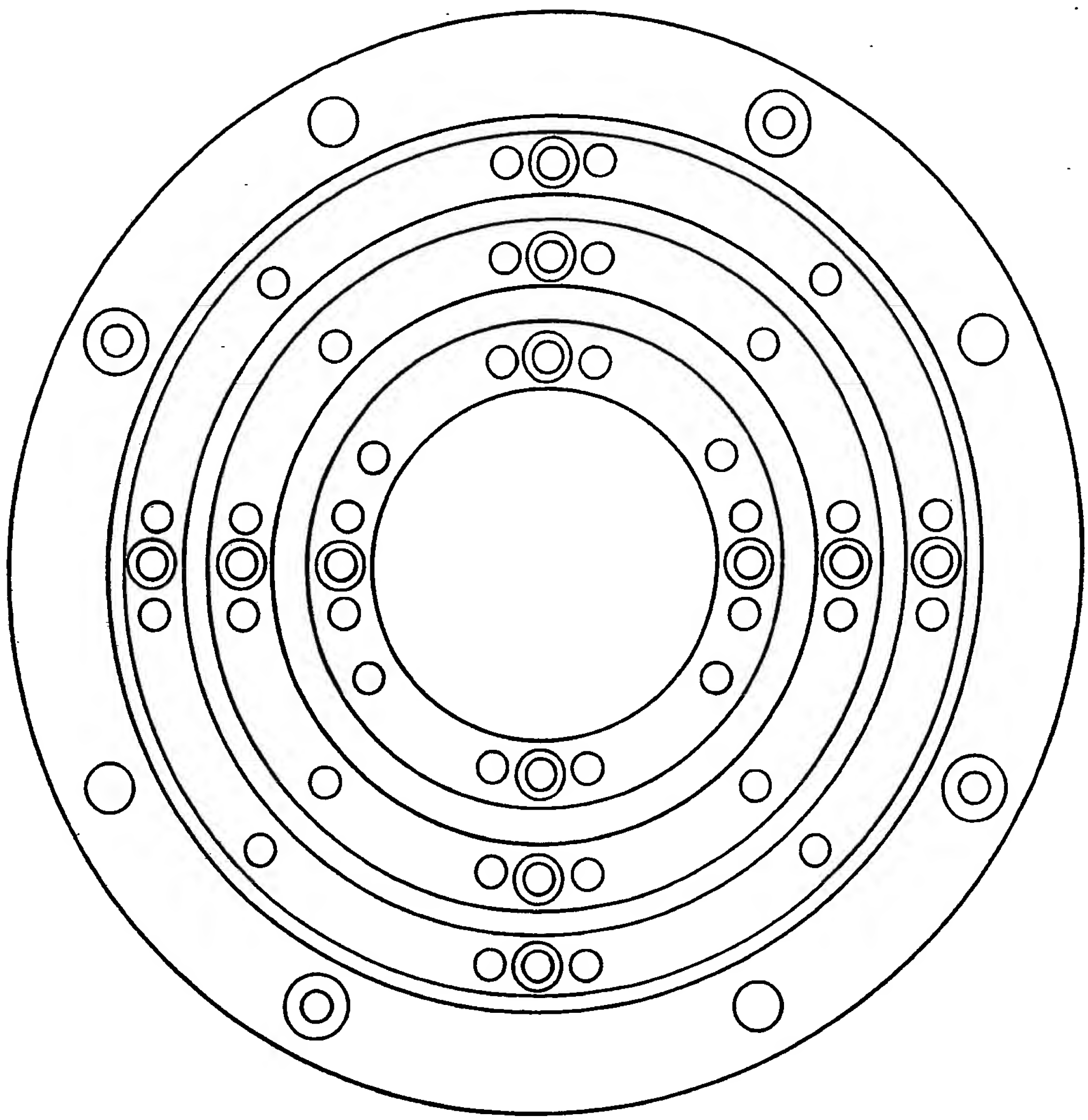


FIG. 29

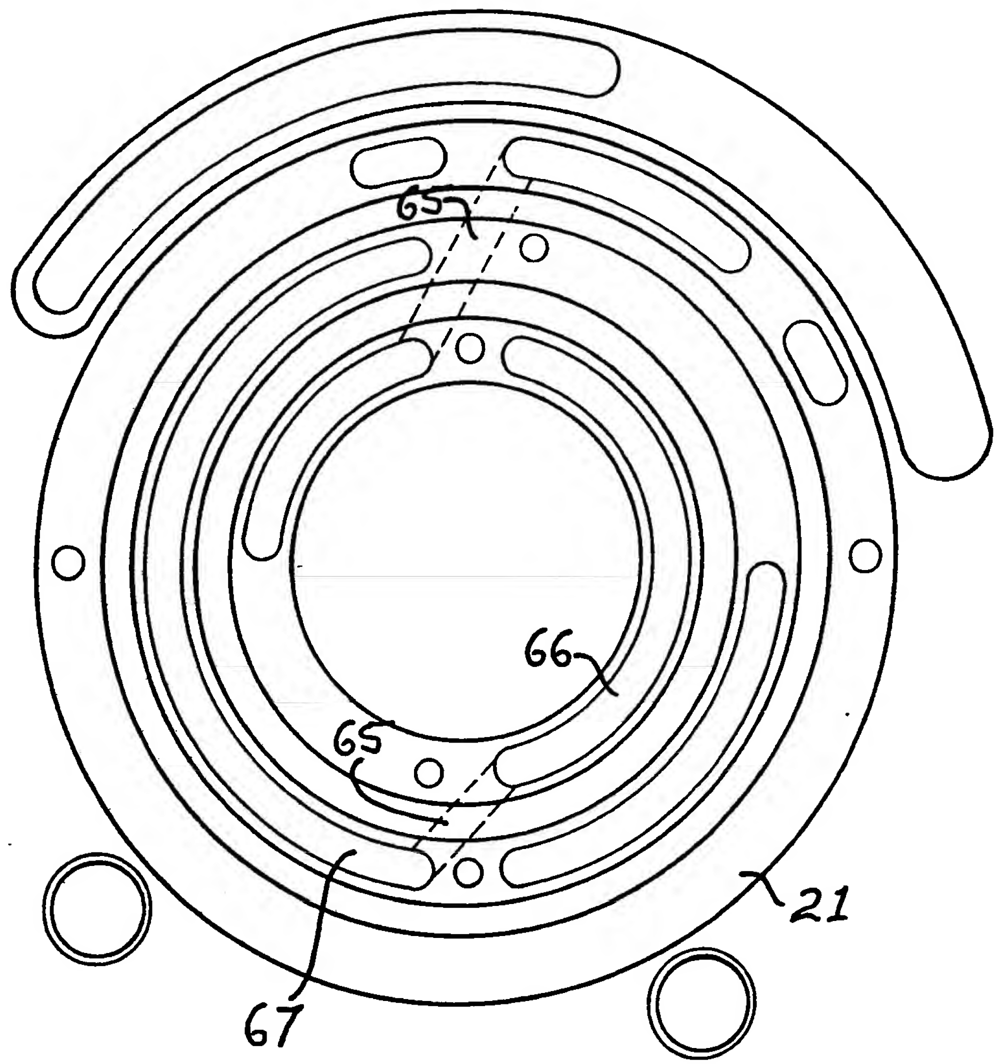


FIG. 30

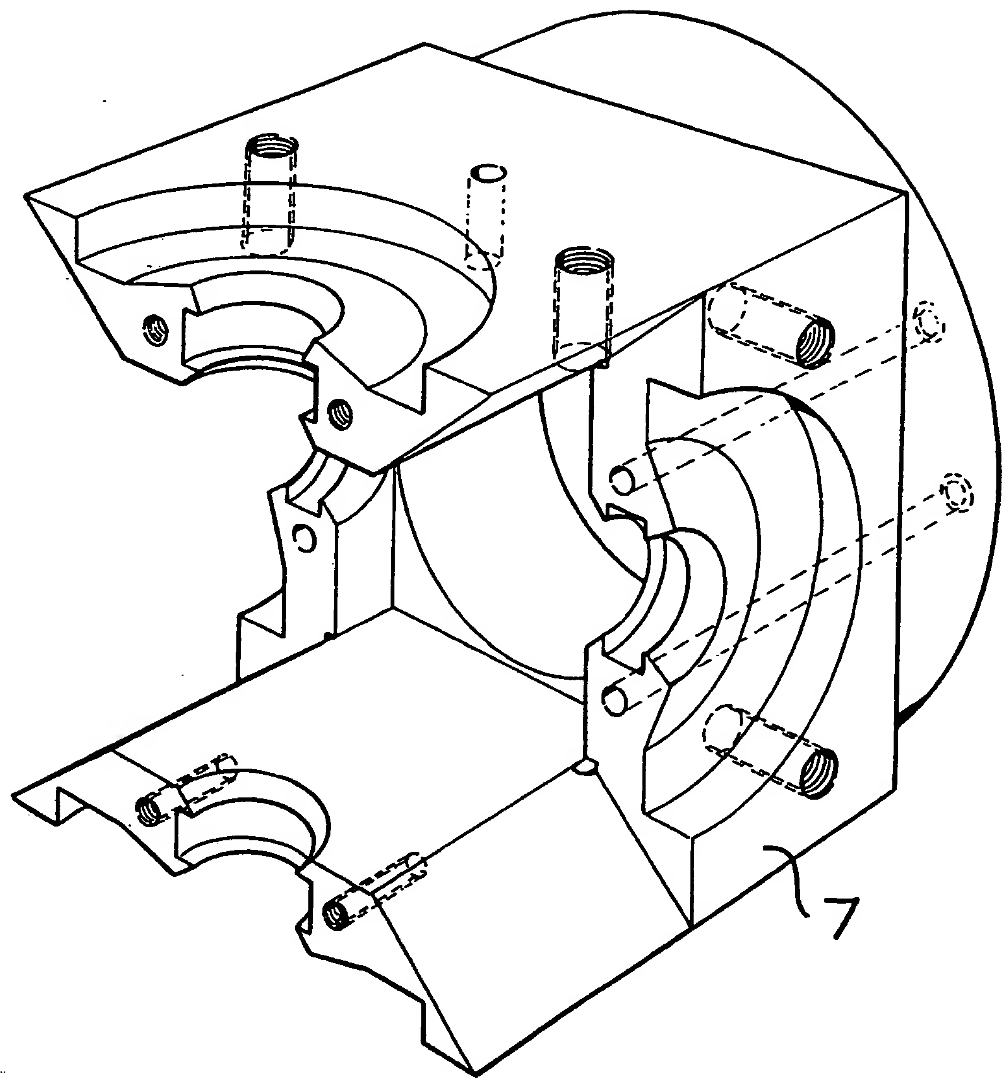


FIG. 31

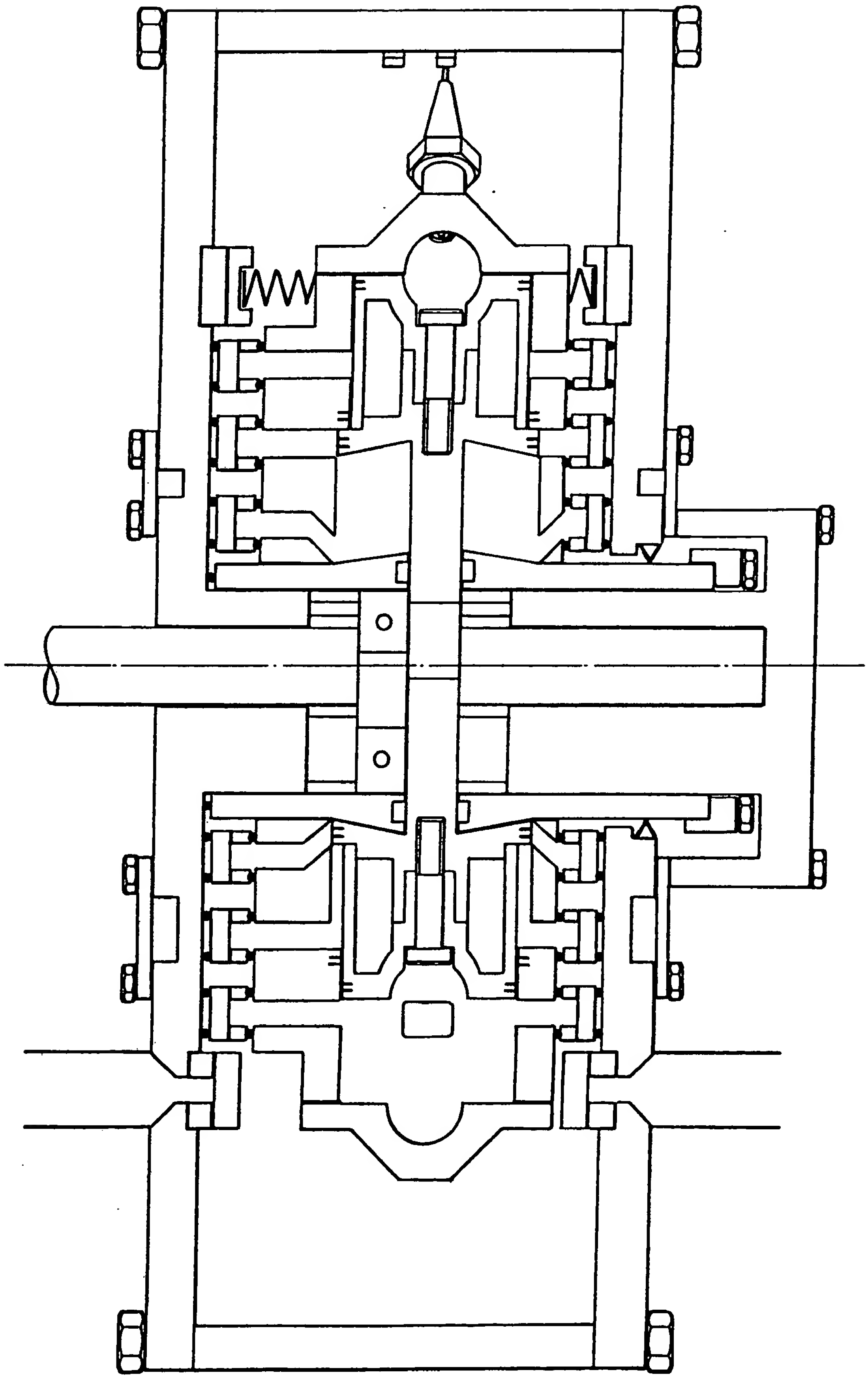


FIG. 72

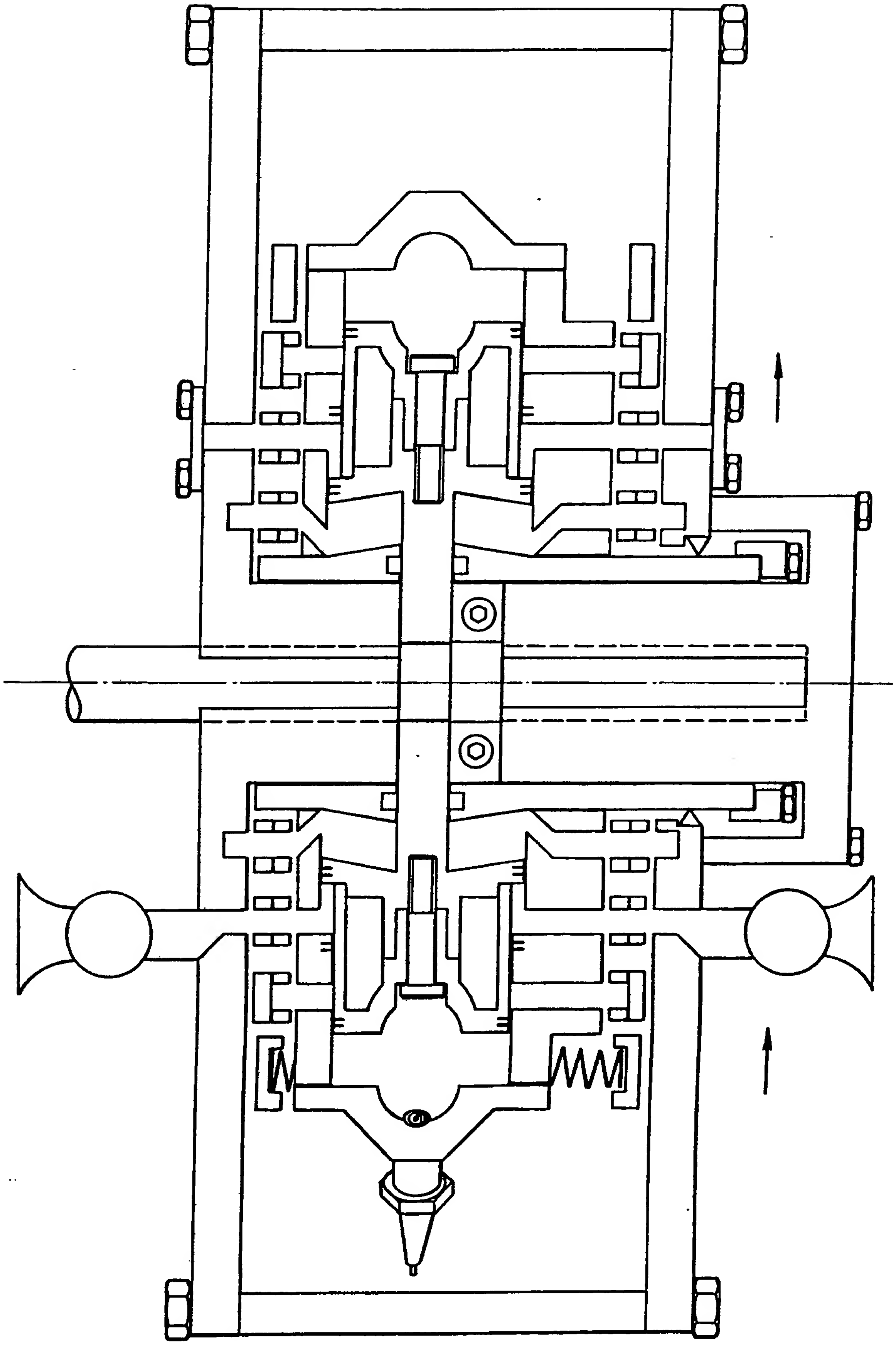
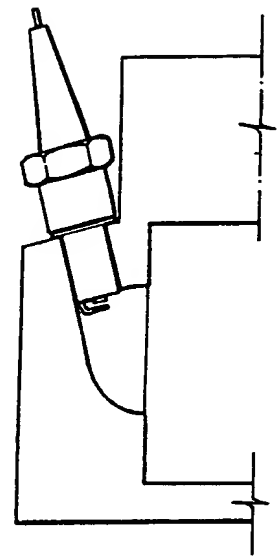


FIG 77



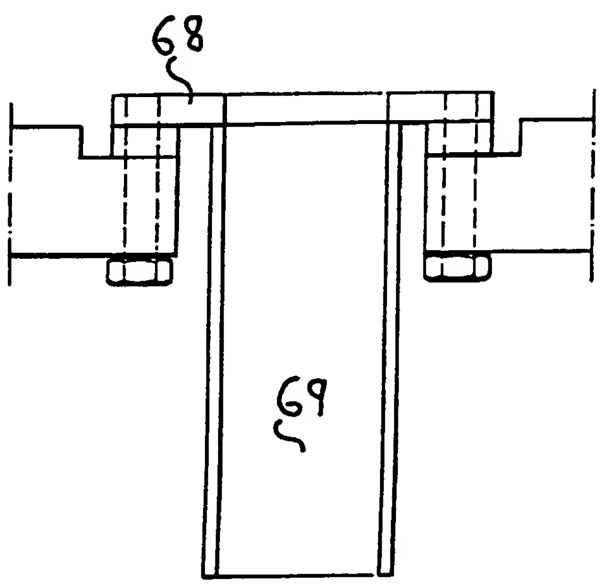


FIG. 34

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU92/00635

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.^{5} F01B 13/00, 13/04, F02B 57/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC F01B 13/00, 13/04, F02B 57/04, F03C 1/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)
DERWENT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
	US,A, 4010719 (LAPPA) 8 March 1977 (08.03.77)	
X	column 3, lines 7-35	1-4
A	column 5, lines 14-44	5-6, 8
	GB,A, 1446852 (ANIDYNE CORPORATION) 18 August 1976 (18.08.76)	
X	page 1, lines 28-47	1
A	page 2, line 16 - page 3, line 105	5-6,8
	US,A, 3865093 (RODRIGUEZ) 11 February 1975 (11.02.75)	
X	column 1, lines 17-36; column 2, lines 63-66	1-3

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 January 1993 (15.01.93)	29 JAN 1993 (29-01-93)

Name and mailing address of the ISA/AU	Authorized officer
AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA	C.M. WYATT
Facsimile No. 06 2853929	Telephone No. (06) 2832538

C(Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
X	DT,A, 2166418 (MOTOREN FORSCHUNGS GmbH & CO. KG) 10 January 1974 (10.01.74) figures 1-5	1-2, 5
X	US,A, 3517651 (GRAYBILL) 30 June 1970 (30.06.70) column 1, lines 12-33	1,5
X	GB,A, 537824 (MAWEN MOTOR CORPORATION) 8 July 1941 (08.07.41) page 2, line 125 - page 3, line 74	1-4
X	US,A, 2273900 (SKLENAR) 24 February 1942 (24.02.42) column 2, line 3 - column 3, line 50	1-4
X	US,A, 2242231 (CANTONI) 20 May 1941 (20.05.41) figure 2; column 3, line 36 - column 4, line 51	1-2, 5

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
GB	1446852	AU	59123/73	BE	803490	DE	2339957
		ES	417826	FR	2196002	IT	990142
		JP	50106205	LU	68207	NL	7311085
		AU	59130/73	BE	803489	DE	2339958
		ES	417822	FR	2196001	GB	1446851
		IT	990141	JP	50111605	LU	68208
		NL	7311084	ZA	7305329	ZA	7305330
US	3865093	DE	2212020	ES	396667	FR	2160014
		GB	1402593	IT	974816	JP	48053103